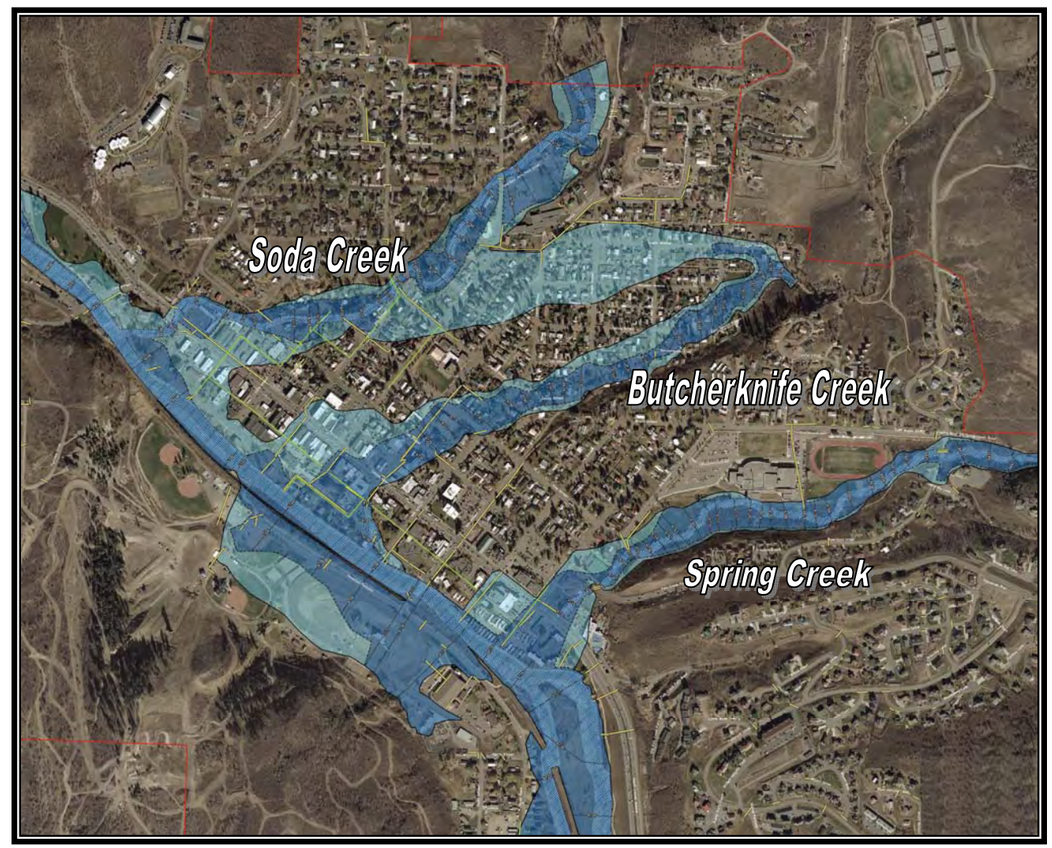
OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTERPLAN
FOR
SODA, BUTCHERKNIFE AND SPRING CREEKS

PRELIMINARY DESIGN REPORT



PREPARED FOR:

City of Steamboat Springs

PREPARED BY:

Engineering Consultants
Your project, our pride.

3151 SOUTH VAUGHN WAY
SUITE 680
AURORA, COLORADO 80014

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PREPARED FOR:

City of Steamboat Springs
124 10th Street
Steamboat Springs, Colorado 80477

PREPARED BY:

J3 Engineering Consultants, Inc.
3151 South Vaughn Way
Suite 680
Aurora, Colorado 80014
Phone: 303-368-5601
Fax: 303-368-5603

J3 ENGINEERING'S JOB NUMBER – 50500101

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTERPLAN
FOR
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LIST OF ABBREVIATIONS

A	TRIBUTARY AREA
AC	ACRES
BK	BUTCHERKNIFE
BW	BOTTOM OF WALL
C	RUNOFF COEFFICIENT
CDOT	COLORADO DEPARTMENT OF TRANSPORTATION
CFM	CERTIFIED FLOODPLAIN MANAGER
CFS	CUBIC FEET PER SECOND
CL	CENTERLINE
CLOMR	CONDITIONAL LETTER OF MAP REVISION
CMP	CORRUGATED METAL PIPE
D	DIAMETER
DFA	DIRECT FLOW AREA
EL	ELEVATION
EX	EXISTING
FEMA	FEDERAL EMERGENCY MANAGEMENT AGENCY
FES	FLARED END SECTION
FIRM	FLOOD INSURANCE RATE MAP
FIS	FLOOD INSURANCE STUDY
FR	FROUDE NUMBER
FT	FEET
GIS	GLOBAL INFORMATION SYSTEMS
GND	GROUND
H	HEIGHT (HIGH)
HDPE	HIGH DENSITY POLYETHYLENE
HEC-RAS	HYDROLOGIC ENGINEERING CENTER – RIVER ANALYSIS SYSTEM
HSG	HYDROLOGIC SOIL GROUP
HW	HEADWALL
I	RAINFALL INTENSITY
IN	INCHES
INV	INVERT
L	LEFT
LOMR	LETTER OF MAP REVISION
MAX	MAXIMUM
MH	MANHOLE
MIN	MINIMUM
N	MANNING'S N
NAD	NORTH AMERICAN DATUM
NAVD	NORTH AMERICAN VERTICAL DATUM
NFIP	NATIONAL FLOOD INSURANCE PROGRAM
OFF	OFFSET
OSP	OUTFALL SYSTEM PLAN
P_1	1-HR POINT RAINFALL DEPTH
PC	POINT OF CURVATURE
PE	PROFESSIONAL ENGINEER
PR	PROPOSED
PRC	POINT OF REVERSE CURVE
PT	POINT OF TANGENT
Q	DISCHARGE
Q_P	PEAK DISCHARGE
Q_{100}	100-YR DISCHARGE
Q_{25}	25-YR DISCHARGE
Q_{10}	10-YR DISCHARGE
Q_5	5-YR DISCHARGE
R	RIGHT
RCBC	REINFORCED CONCRETE BOX CULVERT
RCP	REINFORCED CONCRETE PIPE
S	SLOPE
SB	STILLING BASIN
SO	SODA CREEK
SP	SPRING CREEK
STA	STATION
STM	STORM
T_C	TIME OF CONCENTRATION
TW	TOP OF WALL
TYP	TYPICAL
UDFCD	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
USGS	UNITED STATES GEOLOGICAL SURVEY
W	WIDTH
WQ	WATER QUALITY
US	UNITED STATES
V_N	NORMAL VELOCITY

EXECUTIVE SUMMARY

Old Town Steamboat Springs is the historic, downtown portion of the City. Steamboat Springs is located in the east-central portion of Routt County along US Highway 40, which becomes Lincoln Avenue through the downtown area. The general location of the Old Town Steamboat Springs area encompasses approximately 540 acres which includes Old Town's location at the downstream end of the three major drainageways; Spring Creek, Butcherknife Creek and Soda Creek. As a consequence of the three drainages, the area is susceptible to flooding associated with major storm events and extreme snow melt conditions. Minor events may also result in annual flooding along localized portions of each drainage basin, but to a lesser extent. Local drainage is a problem due to limited existing stormwater infrastructure and so many areas are susceptible to street flooding. To date, drainage solutions have been developed with limited design data and so an inconsistent approach has been applied.

The body of work included with the enclosed study is provided so that the City of Steamboat Spring is able to address past, ongoing, and future drainage challenges within the Old Town area in a clear and consistent way. The City endeavored to create a document that could be used to identify design flows, identify drainage concerns, evaluate flooding potential and present engineering solutions to reduce flooding. This document will help guide future development by providing consistent data.

Redevelopment projects within the Old Town area are expected to increase pressure on the already constructed floodplain(s) and have the potential to alter runoff characteristics. Therefore, this study also enables the City to consider the impacts to the floodplain as redevelopment within the study limits occurs. In some cases, redevelopment projects can be viewed as a "trigger" for certain drainage improvements identified in this drainage study.

This study provides numerous recommendations, including new storm sewer laterals, storm inlets, road crossing improvements, structural enhancements and a consolidation of several stormwater outfalls to the Yampa River. Conceptual designs and cost estimates are included to assist the City with planning efforts so that projects may be prioritized, scheduled and ultimately funded. Many of the improvements are provided to reduce floodplain impacts associated with Butcherknife Creek and Soda Creek. One such improvement is the 8' (W) x 4' (H) reinforced concrete box culvert crossing of Lincoln Avenue for Butcherknife Creek which is currently designed and is scheduled for construction in 2009. This improvement will provide the City with a future connection point for other recommendations in this study.

Detailed data was not always available during the preparation of this study. **The reader is encouraged to review the assumptions and disclaimers located on the subsequent page. Each assumption / disclaimer should be verified before proceeding with final design.**

The goals and objectives described in this study are provided based on the City of Steamboat Springs Engineering Standards, Effective September 2007 (Section 5.0 – Drainage Criteria). The user is required to verify any revisions to the standards and make the appropriate adjustments.

ASSUMPTIONS / DISCLAIMERS

Due to a lack of detailed data during the preparation of this study, several assumptions were necessary for the completion of this report and it is important that the reader understands the implications of those assumptions. The following is a list of assumptions made for the project. Please note that several of these assumptions are further described in more detail within the body of the report.

- Inlets shown in this report are conceptually located. For the purpose of this study, inlets are located at design points where street capacity is exceeded or where a proposed storm sewer makes it convenient to add an inlet rather than conveying flows across intersections with culverts. The reader should not assume that the locations depicted or that the number of inlets shown is final. All recommended improvements shown herein will require a detailed analysis, final design, and a drainage report to be submitted to and approved by the City.
- The report utilized the channel flows from the FIS for the three major drainageways within the Study Area.
- In most cases, GIS information was utilized as the basis of design for this report. Future survey to accurately show grades, utilities, etc. should be provided prior to final design.
- Storm sewer lines, inlets and manholes shown within the report are conceptual. Final horizontal location should be evaluated during final design and after detailed survey information is obtained. Storm sewer was not located vertically, other than verifying that sufficient elevation fall was available.
- Utility conflicts with sanitary sewer, water lines, and dry utilities were noted in this report and may be encountered with what is recommended herein. Final design and detailed survey information may require variation in horizontal location and confirmation of vertical fall.
- Hydrologic calculations assumed Hydrologic Soil Group (HSG) C.
- Corrugated Metal Pipe (CMP) with an associated Manning's n value of 0.027 was utilized for storm sewer preliminary calculations, except where noted.
- Based on Equation 5.9.2 – Initial Storm Sewer Sizing utilized the controlling street slope for calculations and assumed the pipe was parallel in slope.
- Storm water quality was not specifically addressed in this report. However, proposed channel improvements related to erosion control will improve the overall water quality of the system.
- Future projects such as the Yampa Street Streetscape project may dramatically impact basin delineations and the function of local drainage systems. As such improvements to local drainage systems may be required including reevaluation, revised alignments and final design
- In all cases, composite impervious values reflect existing conditions. This method was applied because the Old Town area is largely developed with little open space remaining. The open space that does remain is either located on steep hillsides that are undevelopable or are outside of the city municipal boundary. The two land parcels which meet the later description are located at the top of the hill on Yahmonite Road in the Soda Creek basin and the southeast corner of North Park Road and Strawberry Park Road.
- Improvements related to floodplain improvements are intended to reduce the extent of the mapped FEMA floodplain. At the time of this study, detailed information regarding finished floor elevations and actual flooding impacts to habitable structures was not possible. With that said, reductions to the mapped FEMA floodplain were completed to the best extent possible without requiring major channel work which would have a significant impact to private property. In general, floodplains were reduced by eliminating the overtopping of roadways and by modeling a diversion along Butcherknife Creek. The hydraulic models that were developed to prepare the analysis were based on two-foot GIS topography and field measurements of structure size. Detailed surveys to more accurately model inlet and outlet hydraulics was not possible. This report recommend further studying actual flooding to habitable structures, detailed survey and a final design level analysis before proceeding with any of the proposed channel improvements.
- FEMA will continue to regulate the floodplain described on the FIRM panel until it is formally revised.
- GIS information was utilized for the soil maps and was obtained from the USGS. Discrepancies between the GIS data and aerial information were noted on the soil maps. For example, the red line designating the US Highway 40 does not overlay well with the actual US Highway 40 location. The user should be cautioned to appropriately identify and decipher the information presented on the soil maps.

1.0 INTRODUCTION

1.1 STUDY AUTHORIZATION AND PARTICIPATION

The City of Steamboat Springs (the City), contracted with J3 Engineering Consultants, Inc. (J3) for engineering services to complete a drainage study for the "Old Town" area of the City of Steamboat Springs. The watersheds located within the Old Town Steamboat Springs area include portions of the Soda, Butcherknife and Spring Creek watersheds.

This study for Old Town Steamboat Springs was authorized by the City and the specific tasks completed during this project were performed in accordance with the Professional Services Agreement, Contract No. 50500101 executed on March 31, 2008.

1.2 PURPOSE, SCOPE AND OBJECTIVES

The goal of this project is the creation of a document that will be used as a planning tool and will identify drainage infrastructure needs for approximately 540 acres within the study area as identified in the Request for Proposal. This drainage study will enable the City to strategically address stormwater needs and implement well planned solutions to existing drainage problems and address future drainage needs.

Redevelopment projects within the "Old Town" area are expected to increase pressure on the already constructed floodplain(s) and have the potential to alter runoff characteristics. Therefore, this study assists the City with quantifying the future and existing conditions and enables the City to consider the impacts to the floodplain as redevelopment within the study limits occurs. The improvements may include private and public infrastructure needs and as such, this study will help the City to evaluate the financial impacts and discuss items such as impact fees, cost sharing agreements or the incorporation of these costs into a stormwater utility.

In some cases, redevelopment projects can be viewed as a "trigger" for certain drainage improvements identified in this drainage study. This will occur when the future conditions result in a notable reduction in conveyance, life safety, floodplain, or the level of service within a drainage sub-basin.

Objectives for assessing and developing the Old Town Drainage Study and Floodplain Masterplan for Soda, Butcherknife, and Spring Creeks include:

1. Meet and correspond frequently with City staff to obtain information, present study findings, and discuss the results of the study.
2. Perform a detailed field investigation to assess the stability of the existing channel corridors and to observe field indicators of channel instability such as bank erosion.
3. Inventory and compile the existing infrastructure within the study area.
4. Evaluate the impacts of improvements with regard to property ownership along the study area.
5. Prepare a detailed hydrologic analysis for the existing watershed conditions.
6. Conduct hydraulic analyses along the main stream corridors to; evaluate capacities of existing drainage structures, determine the necessity of increasing conveyance capacity within the channel corridors, and to evaluate functionality impacts to the main channel corridors and floodplain as a function of redevelopment potential.
7. Develop preliminary drainageway improvements concepts that address existing conveyance concerns.
8. Prepare a written report that defines the existing conditions and establish a Masterplan document for the City to use as a guideline for future improvements.

1.3 ACKNOWLEDGEMENTS

J3 Engineering Consultants, Inc. wishes to acknowledge the various individuals who assisted in the preparation of this study. The following individuals and the agencies they represented are:

NAME	REPRESENTING
Mr. Philo S. Shelton III, P.E.	City of Steamboat Springs
Mr. Jim Weber, P.E.	City of Steamboat Springs
Ms. Janet Hruby	City of Steamboat Springs
Mr. Ben Beall	City of Steamboat Springs
Mr. Doug Marsh	City of Steamboat Springs
Mr. Ron Berig	City of Steamboat Springs
Mr. Van Pilaud	Colorado Department of Transportation

The following members of J3's project team contributed to the preparation of this report:

Mr. Ken Cecil, P.E., CFM	Principal / Project Manager
Mr. Jason Margraf, P.E.	Principal / Quality Control / Quality Assurance
Mr. Josh Duncan, P.E., CFM	Project Engineer
Mr. Bryan Clerico, P.E.	Project Engineer

1.4 PROJECT HISTORY AND CORRESPONDENCE

Several progress meetings and field coordination meetings with City staff were held during the course of the project. The meetings provided a discussion of various components of the project, assisted with identifying specific problematic areas and concerns from City staff that have a thorough knowledge of the drainage system, and provided a platform for discussing results and findings of the project.

1.5 SUMMARY OF MAPPING AND DATA OBTAINED

Base information such as jurisdictional and property boundaries, floodplain information, and roadways were obtained from the Routt County Geographic Information Systems (GIS) department. Two-foot contours for the entire study area were provided by the City's GIS Services department. The project mapping was developed from aerial information obtained in 2003. The vertical and horizontal controls are NAVD 29, U.S. Survey Feet and NAD83, CO North – 0501 U.S. Survey Feet, respectively.

Detailed base information and topographic information consisting of one-foot contour intervals was also provided for a portion of the Study Area. Specifically, the limits of the detailed base information area were from Yampa Avenue to Oak Street and approximately 300 feet south of 3rd Street to approximately 300' north of 12th Street. Survey information was provided by Landmark Consultants, Inc. and the work was completed under a separate contract with the City. The base information provided valuable horizontal survey information along the main roadways (alleys and the internal areas

of individual blocks were excluded). Vertical information of underground utilities was limited for the detailed survey area.

1.6 PREVIOUS STUDIES AND REFERENCES

The following reports were reviewed and/or utilized during the course of preparing this report:

1. "City of Steamboat Springs Engineering Standards", prepared by WRC Engineering, Inc. for the City of Steamboat Springs Department of Public Works, Effective September, 2007.
2. "Flood Insurance Study for Routt County, Colorado and Incorporated Areas, Map Number 08107C0877D, Panel 877 of 1475". Federal Emergency Management Agency, Effective February 4, 2005.
3. "Soil Survey Area: Routt Area, Colorado, Parts of Rio Blanco and Routt Counties", United States Department of Agriculture, Natural Resources Conservation Services, Survey Area Date, September 25, 2007.
4. Weatherbase, Routt County, Hayden, Oak Creek, Steamboat Springs, and Yampa, Colorado, July 5, 2001. http://www.weatherbase.com/weather
5. "NOAA Atlas 2, Precipitation – Frequency Atlas of the Western United States, Volume III-Colorado". U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Miller, J.F.; Fredrick, R.H.; Tracey, R.J.
6. "7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 40 feet, Steamboat Springs, Colorado". U.S. Department of the Interior, Geological Survey. 1969
7. "7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 40 feet, Rocky Peak, Colorado". U.S. Department of the Interior, Geological Survey. 1962
8. "Flood Insurance Rate Map, Routt County, Colorado and Incorporated Areas. Panel 877 of 1475, Map Number 08107C0877D". Federal Emergency Management Agency. Effective Date: February 4, 2005.
9. Hydrologic Engineering Center – River Analysis System (HEC-RAS), Version 3.1.3. U.S. Army Corps of Engineers. May 2005.
10. Minutes of Planning Commission Work Session, September 3, 1980, Clayton M. Canfield & Associates memorandum regarding the Space Station and Gopher Foods Property.
11. Topographic survey base information, City of Steamboat Springs GIS Services.
12. Detailed topographic survey base information for the Old Town Steamboat Area. Landmark Consultants, Inc.
13. "Urban Storm Drainage Criteria Manuals, Volumes 1-3". Urban Drainage and Flood Control District. Revised August 2006.
14. "FlowMaster Version 7.0". Haestad Methods, June 2003.
15. "CulvertMaster Version 3.0". Haestad Methods, August 2004.
16. 2007 Colorado Department of Transportation Cost Data. Colorado Department of Transportation.

2.0 DESCRIPTION OF THE STUDY AREA

2.1 LOCATION

Old Town Steamboat Springs is the historic, downtown portion of the City. The City is located in the east-central portion of Routt County along US Highway 40, which is the major transportation route in the region. The general location of the Old Town Steamboat Springs area encompasses portions of Sections 8, 9 16 and 17, Township 6 North, Range 84 West of the 6th Principal Meridian in Routt County, Colorado. The study area has three major drainageways traversing through the Old Town area; Spring Creek, Butcherknife Creek and Soda Creek. Hydraulically, all three streams are right bank tributaries of the Yampa River.

The Old Town Steamboat Springs area will be referred to as the "Study Area" for the remainder of this report. This area is generally bound by the Yampa River to the southwest, the City limits to the north, west and east, and 3rd Street to the southeast. A Vicinity Map is included within the Appendix for reference and depicts the Study Area with the relative alignments of Spring, Butcherknife and Soda Creeks.

2.2 MAJOR DRAINAGE BASINS

The Study Area has three streams that convey snowmelt and storm runoff to the Yampa River. The streams are historically perennial and generally convey flow from North/Northeast to South/Southwest. A brief description of the three streams is provided below.

2.2.1 SODA CREEK

Soda Creek is the northernmost stream conveying runoff through the Study Area and the largest of the three major drainage basins. The watershed is approximately 20.0 square miles at the approximate confluence with the Yampa River. The stream generally flows east to west through the Study Area and its confluence with the Yampa River lies approximately 330 feet upstream of the 13th Street Bridge.

Soda Creek is a perennial stream that conveys flow throughout the year. Within the Study Area, Soda Creek can generally be characterized as a rectangular channel with a channel bottom of approximately 20 feet. The depth varies along the channel and landscape walls or retaining walls confine the majority of the main channel corridor. The channel is relatively stable because it is comprised of a cobble stone bed that greatly reduces vertical movement of the thalweg. There are areas of local bank erosion, especially in the lower reaches between the Yampa River and Oak Street. Soda Creek is an open channel throughout the Study Area and encroachment of properties into the floodplain and resultant confinement of the channel is moderate to severe.

2.2.2 BUTCHERKNIFE CREEK

Butcherknife Creek is the middle tributary, lying between Soda and Spring Creeks. It is the smallest of the three major drainage basins with a tributary area of approximately 3.5 square miles. The confluence of Butcherknife Creek with the Yampa River lies approximately 500 feet downstream of the 5th Street Bridge.

Butcherknife Creek is also a perennial stream that conveys flow throughout the year. Within the Study Area, Butcherknife Creek is difficult to generally characterize because it does not have a consistent cross-section. The cross-section varies in geometry throughout and is comprised of triangular, rectangular, and trapezoidal shaped sections. The depth also varies along the channel but is typically two to three feet deep. There are portions of the channel that are shallower and deeper. Butcherknife Creek has a very confined main channel and a shallow floodplain. Encroachment of properties into the floodplain and the resultant confinement of the channel are severe for the segment of Butcherknife Creek within the Study Area. Several obstructions such as structures, fences and driveway crossings all impede flow once flow exceeds bankfull discharge and overtops the banks. Landscape and retaining walls confine the majority of the main channel corridor. The channel is relatively stable because it is comprised of a cobble stone bed that greatly reduces vertical movement of the thalweg. Butcherknife Creek transitions from an open channel to underground conveyance system near Oak Street. The underground storm sewer conveys baseflow through Old Town and discharges upstream of Yampa Avenue, before the confluence with the Yampa River.

2.2.3 SPRING CREEK

Spring Creek is the southernmost stream conveying runoff through the Old Town Steamboat Springs area. The watershed has a tributary area of approximately 8.4 square miles. The confluence of Spring Creek with the Yampa River lies approximately 750 feet upstream of the 5th Street Bridge.

Of the three major drainageways, Spring Creek has the least amount of encroachment and is the most natural stream corridor. Within the Study Area, Spring Creek generally exhibits a trapezoidal cross section with a wide floodplain. The bottom width typically varies between 8 feet and 20 feet. Portions of Spring Creek are conveyed as piped flow between the confluence with the Yampa River and Lincoln Avenue.

2.3 CLIMATE

The climate of the Old Town Steamboat Springs area is characterized by severe winters and cool summers. Based on the *Flood Insurance Study for Routt County* (Reference 2), the majority of annual precipitation occurs as snow throughout the winter and deep snowpack accumulates as elevation increases. Precipitation varies with elevation in the area. The normal annual precipitation ranges from 24 inches along the Yampa Valley floor to approximately 80 inches in the higher mountain peaks. Snowfall in Steamboat Springs averages approximately 13 feet per year. The snow's moisture content is such that 14 inches of snow is equivalent to 1 inch of precipitation. Snow typically begins to accumulate, especially on the northern facing slopes, beginning in October and snowmelt begins in late April and continues through June and possibly July.

2.4 SOILS

Due to the size of the drainage areas, several soil types are present as shown on the *Soil Conservation Service Soil Survey of Routt Area, Colorado, Parts of Rio Blanco and Routt Counties* (Reference 3) maps located in the Appendix of this report. Differing Hydrologic Soil Groups (HSG) were observed within the Study Area. A breakdown of the soil survey information within the Study Area yielded 46.7%, 47.1%, and 6.0% classified as HSG B, C, and D, respectively (0.2% was classified as water). Soils within the Study Area were evenly divided between HSG B and C and due to the low percentage of Type D soils; the hydrologic analysis for the Site was based on HSG C since it will provide a more conservative approach. Based on visual inspection of the drainage map, the soil groups were divided among the different watersheds similarly to the overall average. Therefore, utilizing the soil characteristics of HSG C for the hydrology analysis for each watershed was assumed to be applicable.

In general terms, Type 'B' soils are identified as having medium runoff, moderate infiltration rates and a moderate erosion hazard while Type 'C' soils are identified as having low infiltration rates when thoroughly wetted, moderate runoff, and moderate to severe erosion hazard. Type 'D' soils are classified as having very slow infiltration rates, high runoff potential, high shrink-swell potential and severe erosion potential.

2.5 FLOOD HISTORY

Based on the watershed's high mountain location and characteristics, two distinctively different types of flood events may cause stream peak flows in any given year; spring snowmelt and rainstorm events or a combination thereof. Spring snowmelt tends to generate the most frequent flooding problems having a comparatively minor peak flood threat. Generalized flood history information for the Study Area was obtained from the Flood Insurance Study (Reference 2) and the significant items pertaining to this report are summarized below:

- The combination of high snowmelt runoff with a localized convective cloudburst storm has generated the major flood events within the City.
- Prior analyses illustrated that the 100-year flood would result from snowmelt augmented by rain, the 500-year flood on the Yampa River would be created from the general storm, and the 500-year flood on the tributary creeks such as Spring, Butcherknife and Soda Creeks, would result from a cloudburst, or localized, rainfall event.
- Flooding from localized, cloudburst storms is a high probability in the Steamboat Springs area.
- Areas within the Study Area are subject to broad, shallow overland flooding. Based on Reference 2, the shallow flooding is predominantly caused by obstructions within flooded areas (such as homes or insufficient capacity of hydraulic structures) and essentially independent of the adjacent drainageways.

Flooding within the City has been previously documented in the Flood Insurance Study (Reference 2). Here is a summary of the historic floods that affected the Study Area per that Reference:

- *June 1921*: "Flooding was widespread in the region in 1921, with highway travel cut off and towns isolated. In Steamboat Springs, flow in Soda Creek was too great to be passed by the Lincoln Avenue crossing, and a large lake formed that surrounded several homes and was backed up by the bridge. Floodwater ultimately flowed over the street in a stream that was a half-block wide, the bridge was damaged and the streambank eroded. Between Lincoln Avenue and the Yampa River, Soda Creek was from 300 to 500 feet wide... The measured stage of the Yampa River in Steamboat Springs indicated a flow of 7,000 cfs, which was 1,000 cfs greater than any flow of record. Flow in Soda Creek was estimated at 2,000 cfs."
- *April 1974:* "all streams in the Steamboat Springs area were higher than at any other time in recent history, but damage occurred principally along Butcherknife Creek. Three days of unseasonably warm weather (which accelerated snowmelt) and a heavy rain triggered flooding that began at 6 p.m. on April 25 and lasted until midnight April 27. Flooding of disastrous levels along the Yampa River and Fish Creek was prevented by 200 to 300 volunteer floodfighters who filled and placed sandbags and built emergency berms at critical locations. However, approximately 50 homes along Butcherknife Creek were surrounded by floodwater, and approximately 300 homes were threatened. A state of emergency was declared on April 26. Flow in the river was approximately 500 cfs above flood stage."

Flood hazard risks are prevalent along the three major drainageways of Soda, Butcherknife and Spring Creeks as well as the Yampa River. Development in the Study Area and directly adjacent to the drainageways occurred long before the current floodplain standards and understanding of the stream corridor significance was emphasized. Although the 100-year flood (or higher) provide the greatest level of risk, nuisance flows and snowmelt cause flooding damage on a regular basis.

2.6 PRELIMINARY IDENTIFICATION OF ISSUES, PROBLEM AREAS, AND LOCATIONS OF RECENT MODIFICATIONS

The purpose of this section is to identify the existing stormwater and floodplain challenges that currently persist within the Study Area. It should be noted that the subsequent hydrologic and hydraulic sections also assisted with identifying problematic or hydraulic insufficient areas.

Multiple meetings were held with City staff to identify problematic areas and concerns throughout the Study Area. Several of these meetings occurred during field visits. A summary of the issues is summarized below:

2.6.1 GENERAL ISSUES

- Lack of general hydrology and design flows within the Study Area.
- Backwater generated by the Yampa River causes additional flooding and hydraulic inefficiencies at the confluences of all three major drainageways.
- The majority of Soda and Butcherknife Creeks and portions of Spring Creek's main channel corridor lie exclusively on private property.
- The stream corridor requires maintenance and rehabilitation often completed by the City. However, the City does not have easements to help gain access for maintenance and construction, or to promote adequate hydraulic conveyance along the stream corridors.
- Currently no stormwater impact fees or similar funding mechanisms are utilized to help fund storm sewer infrastructure improvements throughout the City. Capital improvements are currently paid through the City of Steamboat Springs General Fund.
- Development in the watershed has resulted in minimal improvements to storm sewer infrastructure. Until more recently, developments have been permitted and allowed to provide storm sewer infrastructure necessary to serve their development while downstream or regional infrastructure may be inadequate.
- Portions of the storm sewer infrastructure have been placed in locations that make it difficult to access, maintain, or replace. For example, portions of storm sewer lie underneath buildings within the Study Area such as the 24-inch culvert under the Steamboat Yacht Club.
- High groundwater throughout the watershed occurs during the spring months and snowmelt. Foundation drains and sump pumps tie directly into portions of the existing storm sewer infrastructure and in some instances cause nuisance surface flows. In other areas there are no storm sewers to connect and control discharge of foundation drains.
- Previous retrofits or mitigation improvements are inadequate. Portions of the Study Area utilize an abandoned vitrified clay sanitary sewer to convey storm runoff. The former vitrified sanitary sewer was replaced with a new sanitary sewer, but the pipe continues to operate to serve unidentified roof drain connections.

- On-going development within the floodplain is occurring. The City of Steamboat Springs has implemented a permitting process for all development within the floodplain in order to comply with FEMA requirements as part of the National Flood Insurance Program (NFIP).
- Numerous outfalls for local and major drainage are located along the Yampa River.

2.6.2 SODA CREEK

- Near the newly renovated Bud Werner Library between the Yampa River and Lincoln Avenue, active bank erosion coupled with the failure and deterioration of a crude retaining wall along the right bank of Soda Creek is progressing. The existing retaining wall consists of broken pieces of concrete stacked and filled with native material.
- The orientation of the Lincoln Avenue bridge/culvert creates abrupt bends upstream and downstream along the channel corridor and causes an impediment to flow conveyance.
- Upstream of the Lincoln Avenue culvert, the right bank is eroding and stabilization measures are inadequate. Although stabilization measures are delaying and slowing down the erosive process, continued erosion and bank failure will persist.
- Upstream of Lincoln Avenue, Soda Creek has four to six foot high retaining walls which are in marginal condition and confine the channel.
- The culvert crossings at 11th Street and Oak Street are undersized, the channel is highly confined, and the alignment is skewed.
- The two bridge crossings located at Pine Street and Yahmonite Street have recently been modified to pass the 100-year design flow. The Yahomnite Street Bridge was under construction at the time of this report. The Pine Street Bridge was completed in 2006.
- The configuration of the Pahwintah Street culvert only allows it to develop approximately six feet of headwater before spilling out of its banks onto adjacent residential property and further onto Pahwintah Street. Pahwintah Street rapidly increases in elevation to the north creating approximately 7-feet of cover over the pipe.

2.6.3 BUTCHERKNIFE CREEK

- The confluence of Butcherknife Creek to the Yampa River is slightly oriented in an upstream direction conflicting with normal flow within the Yampa River. This creates additional backwater effects on Butcherknife Creek and causes further hydraulic inefficiencies.
- A concrete retaining wall on the right bank of Butcherknife Creek downstream of Yampa Avenue is failing and will eventually collapse into Butcherknife Creek. At present, it is leaning approximately ten degrees past vertical.
- Butcherknife Creek is currently conveyed under Lincoln Avenue in a masonry culvert between the alleys west and east of Lincoln Avenue. The current horizontal configuration of the storm pipe traverses beneath an existing abandoned gas station and adjacent to a retail shopping building. This is further discussed in Section 3.3.2.
- Butcherknife Creek is very confined in multiple areas along the reach. In most cases, the creek is confined with cobble stone retaining walls in very close proximity to homes or driveways.
- The main channel is close in proximity to numerous homes; within a few feet in specific areas.
- City staff routinely provides sandbags and assistance to residents during the spring runoff. The sandbags are utilized to keep the flow within the channel banks or to prevent flooding damage to adjacent structures.
- Butcherknife Creek has a very confined main channel corridor. However, once flow overtops the main channel banks, its shallow, broad floodplain makes it difficult to prevent damage and predict its flow patterns.
- Ice damming created by driveway crossings cause flooding and other complications throughout Butcherknife Creek during the spring runoff.
- Dry and wet utilities serving residential structures are suspended and exposed along Butcherknife Creek and could be damaged and create additional problems during a large runoff event.
- Cover over some of the culverts is inadequate. In some cases, cover over the culverts was only a couple of inches and the structural integrity of the culvert was compromised.

2.6.4 SPRING CREEK

- A proposed development is replacing the storm pipe that conveys Spring Creek under Lincoln Avenue to the Yampa River. The hydraulics were calculated and construction documents were prepared for the project under a separate scope of services (by others). The construction of the storm sewer was occurring during the creation of this document.

2.7 UTILITIES

Several utilities with differing service owners are present within the Study Area. Those utilities include water, sanitary and storm infrastructure maintained and operated by the City. Dry utilities such as electric, gas, and phone were not included in the coordination. Utility locations presented in this document are based on the detailed survey provided by Landmark Consultants, Inc. and the City GIS department and are approximate. Before any final design and construction activities occur, the Utility Notification Center of Colorado should be contacted to physically locate and identify utilities in the field.

2.8 PROPERTY INFORMATION AND COORDINATION

Property information within the Study Area was available and downloaded from the Routt County GIS Department. Portions of three major streams lie within private property, which requires added coordination with property owners and is a vital factor in recommended improvements. Significant coordination with the local property owners will likely need to occur to obtain permission for construction and disturbance. Depending on the selected future improvements, it may be beneficial for the City to request a drainage or utility easement or to acquire property simply for maintenance access.

3.0 HYDROLOGIC ANALYSIS

3.1 GENERAL

A hydrologic analysis was performed to identify the drainage patterns and characteristics of the project Study Area. The hydrologic analysis was completed for tributary areas directly flowing to the three major drainageways and the Yampa River within the Study Area. The analysis provided a means to evaluate existing drainage deficiencies and ultimately contributed to determining the proposed recommendations for infrastructure and drainage improvements within the Old Town area. Since the Study Area was limited to the Old Town and commercial downtown areas, the hydrologic analysis for the entire creek watersheds was beyond this project Scope of Service.

3.2 PREVIOUS HYDROLOGIC STUDIES

Few studies were available that document hydrologic information for Soda, Butcherknife and Spring Creek. Although limited, the acquired studies were utilized as references to better understand the existing delineation of the floodplain and histories of the drainageways. The majority of previous studies include design information for localized areas of modifications such as bridge improvements or storm sewer infrastructure to serve redeveloped areas. Those studies provided some information about existing infrastructure sizing and locations.

3.3 DESIGN CRITERIA:

3.3.1 REGULATIONS

A drainage plan is presented for the 5-year (minor) and 100-year (major) storm events based on the *City of Steamboat Springs Engineering Standards* (Reference 1). The 10-and 25-year storm recurrence intervals were also evaluated for future design purposes and to determine peak flows for multiple events in order to determine the storm improvements priority levels.

3.3.2 METHODOLOGY

Hydrologic analyses were calculated using the Rational Method. For watershed areas less than 160 acres, the Rational Method can be used. The three key components to the Rational Method are the composite runoff coefficient, rainfall intensity and drainage area. For a given storm recurrence interval, the peak discharge for a drainage basin can be estimated using the following equation:

$$Q = C \times I \times A$$

Where:
Q = Discharge (cfs)
C = Composite Runoff Coefficient
I = Rainfall Intensity (inches per hour)
A = Tributary Area (acres)

3.3.3 DESIGN RAINFALL

Based on Table 5.5.1 of the City of Steamboat Springs Engineering Standards, the 24-hour point precipitation values are based on the NOAA Atlas 2, Volume III and are summarized below:

TABLE 1: Point Rainfall Values for Steamboat Springs

Recurrence Interval	1-Hour Precipitation Depths (inches)	24-Hour Precipitation Depths (inches)
5-year	0.78	1.7
10-year	0.94	1.9
25-year	1.09	2.4
100-year	1.46	2.8

Utilizing the 1-hour point rainfall value, the rainfall intensity can be approximated with the equation:

$$I = \frac{28.5 P_1}{(10 + T_c)^{0.786}}$$

Where:
I = Rainfall Intensity (inches per hour)
P_1 = 1-hr Point rainfall depth (inches)
T_c = Time of Concentration (minutes)

3.3.4 TIME OF CONCENTRATION

Times of concentrations were calculated for each sub-basin utilizing the summation of the overland flow and travel time and are per the *City of Steamboat Springs Engineering Standards*. Overland flow is assumed to occur as sheet flow and travel time is assumed to be a swale, curb and gutter, or paved ditch.

3.3.5 IMPERVIOUSNESS AND RUNOFF COEFFICIENTS

Watershed imperviousness was based on Table 5.6.3 – Recommended Imperviousness Values presented in the *City of Steamboat Springs Engineering Standards* with exceptions and are summarized on the next page.

TABLE 2: Imperviousness Values

Land Use or Surface Characteristic	Percent Impervious
Business	
Commercial Areas	95
Neighborhood Areas	85
Residential	
Single Family (Low Density)	40
Single Family (Medium Density)	45
Single Family (High Density)	50
Multi-Unit (detached)	60
Multi-Unit (attached)	75
Apartments	80
Industrial	
Light Industrial	80
Heavy Industrial	90
Parks, Cemeteries	5
Playgrounds	10
School	50
Railroad Yards	15
Undeveloped Areas	
Historic Flow Analysis	2
Greenbelts, agriculture	2
Off-site flow analysis	45
Streets	
Paved (concrete/asphalt)	100
Gravel	40
Drives and walks	90
Roofs	90
Lawns (all soils)	0

The majority of the Study Area has been developed with residential homes and commercial development. Therefore, existing conditions were analyzed to develop appropriate runoff coefficients and impervious values. Future development within the watershed and associated impacts will need to be analyzed at the time of future development.

During the development of the hydrologic sub-basins and associated runoff calculations, there was a need to classify existing land uses and relevant percent impervious values. This was required to better model the existing conditions within the tributary basins to the as-built conditions. Based on field visits, aerial photos and GIS data, three distinct densities of residential development were apparent, denoted as R1, R2 and R3 at end of Appendix C. Sample blocks within each designation were evaluated to determine specific development characteristics, including percent impervious and runoff coefficients these are provided as figures in the Appendix. It is recommend that subsequent design reports, continued planning efforts and general basin calculations use these residential development designations for increased accuracy of design and for conformance to this Drainage Study.

Generally, the R1, R2 and R3 designations represent lowest development density to highest development density, respectively. Based on review of the existing development within three major basins; Spring Creek, Butcherknife Creek and Soda Creek, consistent pattern of the generated residential designations was observed and further designations were not necessary. This information was applied to the delineated sub-basins based on field, aerial and GIS data inspection to determine boundaries for the individual designations. Subsequently, this information was used to determine and generate the sub-basin runoff rate for the different design storms.

Runoff coefficients for the watershed vary with the storm recurrence interval and are directly related to the percentage imperviousness. Runoff coefficients for the storm recurrence interval were based on Table 5.6.1 – Design Runoff Coefficients presented in the *City of Steamboat Springs Engineering Standards* and are provided below:

TABLE 3: Design Runoff Coefficients

Percentage Imperviousness	Runoff Coefficients			
	5-yr	10-yr	25-yr	100-yr
0%	0.15	0.25	0.37	0.50
5%	0.18	0.28	0.39	0.52
10%	0.21	0.30	0.41	0.53
15%	0.24	0.32	0.43	0.54
20%	0.26	0.34	0.44	0.55
25%	0.28	0.36	0.46	0.56
30%	0.30	0.38	0.47	0.57
35%	0.33	0.40	0.48	0.57
40%	0.35	0.42	0.50	0.58
45%	0.37	0.44	0.51	0.59
50%	0.40	0.46	0.53	0.60
55%	0.43	0.48	0.55	0.62
60%	0.46	0.51	0.57	0.63
65%	0.49	0.54	0.59	0.65
70%	0.53	0.57	0.62	0.68
75%	0.58	0.62	0.66	0.71
80%	0.63	0.66	0.70	0.74
85%	0.68	0.71	0.75	0.79
90%	0.75	0.77	0.80	0.83
95%	0.82	0.84	0.87	0.89
100%	0.90	0.92	0.94	0.96

3.4 HYDROLOGIC ANALYSIS AND ROUTING

Watershed basins were delineated to estimate peak runoff quantities for the multiple storm recurrence intervals at specific points within Old Town. The Study Area major drainage basins and direct flow area to the Yampa River were delineated and alphanumeric characters were designated to specify the major drainageway that each basin is tributary to. Portions of the downtown area were not tributary to any of the major creeks but were considered direct flow area (DFA) to the Yampa River. Specifically, major basins were delineated with SP, BK, SO, DFA to describe Spring Creek, Butcherknife Creek, Soda Creek, and Direct Flow Area to the Yampa River, respectively. Drainage basin designations within each major watershed were further refined to identify minor-basins and are designated with an alphanumeric character (i.e. A). Minor basins were then subdivided into sub-basins to route runoff and determine peak flows at locations such as culverts and at critical locations to verify that conveyance capacities were not exceeded. These sub-basins are identified with consecutive numeric characters added to the basin numeric identifiers (i.e. Basin A is sub-divided in to basins A1, A2, etc.) Design Points are consistent with sub-basin designations and refer to points where basin runoff is quantified (i.e. DP A1).

No existing detention facilities, inadvertent detention or retention storage was accounted for in the hydrologic analyses or modeled. A few localized on-Site detention and water quality facilities exist within the Study Area; however, these facilities are not currently under public ownership nor maintained by the City of Steamboat Springs, subsequently the operation and proper functioning of these facilities cannot be guaranteed. Roadway embankments presently cause inadvertent storage but as the capacity of culverts is increased with construction, the storage should decrease. Therefore, this storage was also not included in the analysis. Please refer Section 5.0 and 6.0 for additional discussion of the hydraulic analysis within the Study Area.

3.5 RESULTS OF THE HYDROLOGIC ANALYSIS

Appendix C includes all of the hydrologic mapping used in this study and is organized as follows.

Figure C1 - Overall drainage basin Keymap for Soda Creek
Figures C2 – C6 – Detailed drainage maps for the Soda Creek Basin

Figure C7 – Overall drainage basin Keymap for Butcherknife Creek
Figures C8 – C9 – Detailed drainage maps for the Butcherknife Creek Basin

Figure C10 – Overall drainage basin Keymap for Spring Creek
Figures C11 – C12 – Detailed drainage maps for the Spring Creek Basin

Figure C13 – Overall drainage basin Keymap for Yampa Direct Flow Area
Figures C14 – C15 – Detailed drainage maps for the Yampa Direct Flow Basin

The detailed drainage maps provide sub-basin, design points, and flow characteristics. Each of these figures should be used in conjunction with Tables 4, 5, and 6 located on the following pages to determine design flows at all study area design points. The results include peak flows for the 5-year, 10-year, 25-year, and 100-year design storms. This information should be used for the final design of any of the proposed improvements described herein. The information should also be used to implement projects that are impacted, or have the potential to impact storm sewer infrastructure or have an adverse impact to adjacent, downstream, and even upstream properties.

Review of the figures shows the two-foot project mapping used to delineate the basin boundaries. For additional information regarding the mapping, please refer to Section 1.5. A field review of the Old Town area was necessary to refine several of the basin boundaries where a clear basin distinction could not be easily determined. The basins range in size from 0.32 acres to 40.60 acres.

The detailed hydrologic calculations are included in Appendix C.

TABLE 4: Hydrologic Results of Butcherknife Creek (BK)

Major Basin	Design Point	Tributary Drainage Basins	Tributary Area (acres)	Q_5 (cfs)	Q_{10} (cfs)	Q_{25} (cfs)	Q_{100} (cfs)
BK	A1	A1	5.92	3.7	6.1	9.2	15.6
	A2	A2	5.53	4.7	7.0	9.8	15.6
	A3	A3	3.08	2.5	3.8	5.4	8.6
	A4	A4	2.42	1.7	2.4	3.3	5.1
	B1	B1	2.95	2.1	3.4	4.9	8.1
	B2	B2	4.06	2.9	4.0	5.4	8.2
	B3	B3	3.93	2.7	3.9	5.2	8.1
	C1	C1	5.67	3.4	4.9	6.6	10.2
	C2	C2	6.48	4.6	6.4	8.5	12.9
	C2	C1 & C2	12.15	7.3	10.2	13.7	20.9
	C3	C3	4.69	3.4	4.7	6.3	9.6
	C3	C1, C2 & C3	16.84	9.2	12.9	17.3	26.5
	C4	C4	6.57	4.3	6.2	8.6	13.3
	D1	D1	4.89	3.3	4.8	6.5	10.2
	E1	E1	3.23	2.5	3.4	4.6	7.0
	E2	E2	1.59	1.5	2.1	2.9	4.3
	E2	E1 & E2	4.82	3.7	5.1	6.8	10.3
	F1	F1	3.52	5.1	6.6	8.2	11.8
	F2	F2	0.78	1.9	2.3	2.7	3.7
	F3	F3	3.38	5.4	7.0	8.6	12.3
	F3	F1, F2 & F3	7.68	11.3	14.4	17.8	25.3
	F4	F4	3.48	7.5	9.3	11.2	15.6
	F4	F1, F2, F3 & F4	11.16	17.3	22.0	26.8	37.8
	F5	F5	3.10	7.4	9.1	10.8	14.7

TABLE 5: Hydrologic Results of Soda Creek (SO)

Major Basin	Design Point	Tributary Drainage Basins	Tributary Area (acres)	Q_5 (cfs)	Q_{10} (cfs)	Q_{25} (cfs)	Q_{100} (cfs)
SO	A1	A1	9.4	5.4	8.1	11.5	18.4
	A2	A2	7.4	3.7	5.9	8.7	14.5
	A3	A3	4.0	2.7	3.9	5.3	8.3
	A4	A4	6.5	2.8	5.3	7.7	12.5
	B1	B1	40.6	15.0	27.8	44.7	79.5
	B2	B2	16.3	6.7	11.6	18.0	31.1
	B3	B3	7.9	5.4	7.9	11.0	17.3
	B3	B1, B2 & B3	64.8	24.6	43.1	67.1	116.4
	B4	B4	13.6	4.6	8.1	12.5	21.6
	B4	B1, B2, B3 & B4	78.3	26.4	46.1	71.8	124.5
	B5	B5	12.3	5.3	8.8	13.1	22.2
	B5	B1, B2, B3, B4 & B5	90.7	29.5	51.0	78.9	136.4
	B6	B6	12.3	9.6	13.9	19.1	29.6
	B6	B1, B2, B3, B4, B5 & B6	103	35.6	59.8	90.9	154.8
	B7	B7	6.17	4.2	6.0	8.3	12.9
	B8	B8	2.64	2.4	3.4	4.7	7.4
	B8	B1, B2, B3, B4, B5, B6, B7 & B8	111.81	38.9	64.3	96.8	163.7
	B9	B9	5.32	3.6	5.1	7.1	11.0
	B10	B10	2.31	1.6	2.3	3.2	5.0
	B10	B1, B2, B3, B4, B5, B6, B7, B8, B9 &B10	119.44	41.5	67.7	101.3	170.2
	B11	B11	7.3	4.8	6.9	9.5	14.8
	B11	B1, B2, B3, B4, B5, B6, B7, B8, B9, B10, & B11	126.74	43.8	70.9	105.5	176.4
	C1	C1	40.2	15.2	26.7	41.7	72.7
	C2	C2	8	3.7	6.4	9.8	17.0
	C2	C1 & C2	48.2	18.4	32.1	49.9	87.0
	C3	C3	14.17	9.3	15.8	21.4	33.1
	C3	C1, C2, C6 & C3	70.72	28.3	47.8	70.7	118.2
	C4	C4	9.25	5.7	10.6	14.7	23.3
	C5	C5	4.06	4.2	5.8	7.5	11.3
	C5	C1, C2, C3, C4, C5 & C6	84.03	34.0	57.1	83.1	137.1
	C7	C7	2.78	2.4	3.5	4.9	7.5
	C7	C1, C2, C3, C4, C5, C6 & C7	86.81	34.4	57.5	83.6	137.6
	C6	C6	8.35	5.1	7.4	10.3	16.1
	D1	D1	3.57	1.6	2.9	4.2	6.8
	D2	D2	4.7	3.7	5.3	7.1	11.1
	D2	D1 & D2	8.27	4.6	7.2	10.0	15.7
	D3	D3	2.68	2.0	3.3	4.5	7.2
	D4	D4	1.99	1.8	2.7	3.7	5.7
	E1	E1	17.13	12.6	18.7	26.3	41.8
	E2	E2	4.9	3.3	5.0	6.9	10.8

TABLE 5: Hydrologic Results of Soda Creek (continued)

Major Basin	Design Point	Tributary Drainage Basins	Tributary Area (acres)	Q_5 (cfs)	Q_{10} (cfs)	Q_{25} (cfs)	Q_{100} (cfs)
SO	F1	F1	18.38	11.02	16.41	23.13	36.71
	F2	F2	11.85	5.67	9.48	14.41	24.49
	F3	F3	2.42	2.05	2.97	4.10	6.37
	F3	F1 & F3	20.80	12.33	18.29	25.72	40.72
	F4	F4	3.12	3.76	4.90	6.17	8.92
	F5	F5	11.26	6.72	9.64	13.03	20.20
	F5	F1, F2, F3, F4 , F5 & F6	52.09	26.70	39.47	55.01	87.14
	F6	F6	5.06	3.29	4.71	6.34	9.82
	F7	F7	5.70	3.67	5.27	7.24	11.22
	F7	F1, F2, F3, F4, F5, F6 & F7	57.79	29.50	43.47	60.51	95.63
	F8	F8	2.56	1.86	2.66	3.58	5.55
	F8	F1, F2, F3, F4, F5, F6, F7 & F8	60.35	29.28	43.10	59.90	94.59
	F9	F9	3.60	2.82	3.96	5.30	8.11
	G1	G1	10.55	6.79	5.93	12.64	19.22
	G2	G2	6.22	4.25	8.88	7.93	12.08
	G3	G3	6.48	6.81	7.91	11.12	16.08
	G4	G4	5.93	5.94	27.13	10.03	14.73
	G4	G3 & G4	12.41	18.84	0.00	37.14	58.90
	H1	H1	2.30	5.19	6.25	7.25	9.71
	H2	H2	2.56	5.74	6.92	8.02	10.74
	H2	H1 & H2	4.86	10.19	12.28	14.24	19.07
	H3	H3	2.86	6.81	8.21	9.52	12.75
	H3	H1 , H2, H3	7.72	15.14	18.25	21.16	28.35
	H4	H4	0.40	0.95	1.15	1.33	1.78

TABLE 6: Hydrologic Results of Spring Creek

Major Basin	Design Point	Tributary Drainage Basins	Tributary Area (acres)	Q_5 (cfs)	Q_{10} (cfs)	Q_{25} (cfs)	Q_{100} (cfs)
SP	G1	G1	21.9	11.1	16.0	22.1	34.4
	G2	G2	8.9	7.0	10.1	13.5	21.0
	G2	G1 & G2	30.8	14.3	20.7	28.3	44.0
	G3	G3	1.1	0.0	0.8	1.3	2.3
	G3	G1, G2 & G3	31.9	14.2	21.0	28.9	45.0
	H1	H1	25.7	14.1	24.4	34.1	54.1
	I1	I1	5.2	4.3	6.2	8.3	12.9
	J1	J1	2.4	5.7	7.0	8.3	11.4
	K1	K1	1.1	2.6	3.2	3.8	5.2
	L1	L1	1.4	3.3	4.1	4.9	6.7

TABLE 7: Hydrologic Results of DFA - Yampa

Major Basin	Design Point	Tributary Drainage Basins	Tributary Area (acres)	Q_5 (cfs)	Q_{10} (cfs)	Q_{25} (cfs)	Q_{100} (cfs)
DFA - Yampa	Y1	Y1	2.72	6.00	7.39	8.76	11.98
	Y2	Y2	0.27	0.64	0.79	0.94	1.28
	Y2	Y2 & Y3	0.85	1.94	2.39	2.83	3.87
	Y3	Y3	0.58	1.38	1.70	2.02	2.76
	Y4	Y4	2.90	6.11	7.52	8.91	12.19
	Y2	Y2, Y3 & Y4	3.75	7.90	9.52	11.04	14.78
	Y5	Y5	3.39	7.72	9.51	11.27	15.41
	Y6	Y6	0.12	0.29	0.35	0.42	0.57
	Y6	Y6 & Y7	1.85	4.06	4.89	5.67	7.59
	Y7	Y7	1.73	3.87	4.77	5.65	7.73
	Y8	Y8	0.11	0.26	0.32	0.37	0.49
	Y8	Y6, Y7 & Y8	1.96	3.90	4.70	5.45	7.30
	Y9	Y9	1.71	3.87	4.77	5.65	7.72
	Y9	Y6, Y7, Y8 & Y9	3.67	7.15	8.62	10.00	13.39
	Y10	Y10	2.98	6.79	8.19	9.49	12.72
	Y10	Y6, Y7, Y8, Y9 & Y10	6.65	12.09	14.57	16.90	22.63
	Y11	Y11	2.62	5.63	6.78	7.86	10.53
	Y12	Y12	0.33	0.79	0.95	1.10	1.47
	Y12	Y11 & Y12	2.95	6.23	7.50	8.70	11.65
	Y13	Y13	0.11	0.26	0.32	0.37	0.49
	Y13	Y11, Y12 & Y13	3.06	6.16	7.42	8.61	11.53
	Y14	Y14	0.29	0.69	0.85	1.01	1.38
	Y14	Y11, Y12, Y13 & Y14	4.87	9.40	11.32	13.13	17.59
	Y15	Y15	1.52	3.62	4.36	5.06	6.77
	Y20	Y20	2.07	4.9	6.0	7.1	9.7
	Y21	Y21	1.26	3.0	3.7	4.4	6.0
	Y22	Y22	3.26	7.7	9.5	11.3	15.4
	Y22	Y20 & Y22	5.33	11.7	14.1	16.3	21.9
	Y23b	Y23b	7.85	5.5	7.9	10.7	16.7
	Y23a	Y23a	4.59	3.6	5.1	6.8	10.6
	Y23a	Y23a and Y23b	12.44	8.2	11.7	15.8	24.5
	Y23	Y23	3.14	3.0	4.1	5.5	8.3
	Y23	Y23, Y23a and Y23b	15.58	10.3	14.6	19.7	30.4
	Y24	Y24	1.00	1.0	1.2	1.4	1.8
	Y25	Y25	0.32	0.8	0.9	1.1	1.4
	Y24	Y24 & Y25	1.32	1.7	2.0	2.3	3.1
	Y26	Y26	3.41	8.1	9.8	11.3	15.2
	Y26	Y21, Y23 & Y26	20.25	17.3	23.2	29.6	43.7
	Y27	Y27	3.32	7.9	9.5	11.0	14.8
	Y27	Y21, Y23, Y26 & Y27	23.57	22.1	28.9	36.2	52.4
	Y28	Y28	1.68	4.0	4.8	5.6	7.5
	Y28	Y24, Y25 & Y28	3.00	5.1	6.2	7.2	9.6
	Y29	Y29	1.79	4.3	5.1	6.0	8.0
	Y29	Y24, Y25, Y28 & Y29	4.79	8.8	10.6	12.3	16.4
	Y30	Y30	1.37	3.3	3.9	4.6	6.1
	Y30	Y30	6.16	11.5	13.9	16.1	21.6

4.0 HYDRAULIC ANALYSIS OF FLOODPLAINS

4.1 GENERAL

As previously discussed, the *Flood Insurance Study for Routt County, Colorado and Incorporated Areas* by the Federal Emergency Management Agency dated February, 4 2005 (Reference 2) is the regulated flood insurance study (FIS) for Spring, Soda, and Butcherknife Creeks. Reference 9 was the fourth revision for the flood hazard information for Routt County. The upstream limit of the detailed study for the FIS was at the City of Steamboat Springs Limits, which corresponds to the upstream limit of Study Area.

4.2 HYDRAULIC ANALYSIS APPROACH

To approximate the existing floodplain and to assess impacts to the floodplain based on proposed improvements, the Hydrologic Engineering Center – River Analysis System (HEC-RAS) software created by the United States Army Corps of Engineers (Reference 9) was utilized.

Effective models for Soda, Butcherknife and Spring Creeks were not available for this project. In most cases, the base model (effective model) utilized to define the existing floodplains delineated on the FEMA FIRM map can be obtained from FEMA, the governing municipality or the engineer of record who performed the modeling. Although the effective models within this study area were established in 2005, the models were not available and therefore needed to be recreated. Effective models were recreated for Soda and Butcherknife Creeks and are referred to as corrected effective models. The Routt County FIS only provides base flow data and a work map for each creek but does not detail specific input data for each cross-section such as Manning's coefficient, structure dimensions, blocked obstructions or ineffective flow areas. Therefore, the corrected effective models were developed using the original Routt County designated cross sections and the supplemental input data collected during the course of this project. This includes general field measurements of roadway crossings but no detailed survey. The models were calibrated to match FEMA's effective floodplain delineations to the best extent possible. In some areas, the FEMA delineations appear to be incorrect and where this is the case, no attempt was made to match the FEMA delineation. For example, several cross sections included vastly different base flood elevations for left and right banks. The corrected effective models provide the basis of comparison for the subsequent hydraulic analysis of floodplain modifications resulting from conveyance improvements and or flow diversions and modeled in the proposed conditions hydraulic model. (Note: Proposed conditions only include conveyance improvements and flow diversions. Maintenance issues such as erosion protection and boulder edging are not included with the proposed condition hydraulic model.) The 100-year design flows for the study area are shown in Table 8.

Note: The City of Steamboat Springs excluded Spring Creek from the analysis because improvements to the stream corridor were not anticipated in the Masterplan and an improved culvert crossing of Lincoln Avenue was being implemented at the time of this study.

4.3 PREVIOUS STUDIES

The aforementioned *Flood Insurance Study* (Reference 2) is the only significant detailed reference for the Study Area. The portions of Spring, Butcherknife and Soda Creeks within the Study Area lie within a designated Federal Emergency Management Agency (FEMA) floodplain as defined on the Flood Insurance Rate Map (FIRM) Map Panel Number 08107C0877D, Panel 877 of 1475. Per the FIRM Map Panel, all three creeks have defined 100-year floodplain with base flood elevations (Zone AE) and the 500-year floodplain (Zone X) has been defined within the study area. There are localized areas of Zone AO (shallow areas of flooding) within the study area.

The summary of discharges developed with the *Flood Insurance Study* (Reference 2) are summarized in Table 8.

Table 8: Summary of Discharges from Routt County FIS

Flooding Source and Location	Drainage Area (sq. mi.)	Peak Discharges (cfs)			
		10-year	50-year	100-year	500-year
Spring Creek (120 feet upstream of Lincoln Avenue)	8.4	175	325	650	2,350
Butcherknife Creek (100 feet upstrream of Yampa Avenue)	3.5	75	100	325	1,300
Soda Creek (180 feet downstream of Lincoln Avenue)	20.0	850	1,025	1,300	2,875
Yampa River (Downstream limit of City of Steamboat Springs)	614	7,000	8,450	9,020	10,220

4.4 MAJOR DRAINAGE STRUCTURE INVENTORY

Several local and collector roads upstream of Lincoln Avenue cross the three major creeks within the Old Town study area. At these locations, culverts have been constructed to pass base flows. In addition, development along Lincoln Avenue has required Spring and Butcherknife Creeks to be conveyed to the Yampa River in large diameter storm pipe. Hydraulic backwater calculations were prepared using HEC-RAS for the existing infrastructure to access each crossing's conveyance capacity for the 100-year runoff event. Detailed descriptions of the crossings and or major conveyance elements are illustrated in Section 4.4.1 and 4.4.2 for each drainageway. Dimensions not provided in the detailed survey were supplemented by field measurements and are used to approximate the dimensions of crossings. Detailed dimensions would be required for any final design considerations.

4.4.1 SODA CREEK

- Lincoln Avenue
  20 foot wide by 7 foot high arched bridge/culvert. The existing culvert alignment is skewed and the channel sharply bends upstream and downstream. The headwalls on both the upstream and downstream sides have structural damage in the forms of cracks and deterioration, and the rebar is exposed. The lack of a structural wingwalls on both the upstream and downstream sides of the culvert has contributed to bank failure, bank slumping and erosion.
- 11th Street
  Dual 8 foot wide by 6 foot high corrugated metal pipe (CMP) arch culverts.
- Oak Street
  Dual 8 foot wide by 6 foot high concrete bridge
- Pine Street
  Constructed in 2006, the bridge top length is approximately 42.0 feet.

- ☐ Yahmonite Street
  Bridge currently under construction at the time of this report. Based on the approved plans, the proposed bridge length is 39.0 feet and the overall width of 32.5 feet.
- ☐ Pahwintah Street
  35 foot wide by 11 foot high CMP arch culvert. This structure is capable of developing approximately six feet of headwater before spilling out of its banks and onto Pahwintah Street.

4.4.2 BUTCHERKNIFE CREEK

- ☐ Yampa Avenue
  Dual 48" CMP culverts. Provides connection between the Eagle Scout Park open channel and the Yampa River.
- ☐ Alley South of Lincoln Avenue to Alley North of North Lincoln Avenue
  This reach consists of a closed conduit of varied size. The project survey located a 48" CMP culvert downstream from Lincoln Avenue. However, a concurrent development project replaced a portion of this with 54" CMP adjacent to Ghost Ranch Saloon. As-built drawings for the Lincoln Avenue water main replacement project show a 9' (W) x 6' (H) masonry culvert (outside dimensions) located within the Lincoln Avenue right-of-way. Finally, a memorandum provided by Clayton M. Canfield & Associates (Reference 10) describes the alignment and culvert sizes beneath the Space Station and Gopher Foods property as a 9.75' (W) x 6.9'(H) semicircular top concrete culvert as well as a six-foot diameter CMP at the upstream end which crosses the alley north of Lincoln Avenue.
- ☐ Oak Street
  A 48" CMP
- ☐ Alley Between Oak Street and Pine Street
  A 48" CMP
- ☐ Pine Street
  A 48" CMP
- ☐ Short Street Bridge
  An approximate 10'-6" long bridge with a girder depth of two-feet. The depth from the bottom of the girder to the channel invert is approximately two-feet.
- ☐ Butcherknife Alley
  A 68" x 45" corrugated metal pipe arch culvert
- ☐ Spruce Street
  A 72" x 40" corrugated metal pipe arch culvert

An inventory of Spring Creek culverts was not completed as part of the floodplain Masterplan.

4.5 EVAULATION OF EXISTING FLOODPLAIN

Based on the review of the Routt County FIS as well as the modeling results of the corrected effective model, it would appear that The FEMA regulated floodplain described on FIRM panel number 08107C0877D may not accurately reflect the 100-year floodplain along Soda Creek and Butcherknife Creek. This is most evidenced in the base flood elevation discrepancies noted in Section 4.1. Furthermore, the bridges at Yahmonite Street and Pine Street were constructed subsequent to the Routt County FIS and are therefore not part of that analysis.

The corrected effective model floodplain delineations indicate a net reduction in the overall impacted area. However, while some areas are removed from the floodplain, other areas are added. This is caused by numerous limiting factors including structure details, data discrepancies, obstructions, and mapping used to generate the delineations. The FIS indicates that floodplain boundaries were interpolated between cross sections using mapping with a contour interval of five feet or less. This project interpolated between cross sections using mapping with a contour interval of two feet. In either case, FEMA will continue to regulate the floodplain described on the FIRM panel until it is formally revised. Therefore, the corrected effective model is only useful herein as a tool to compare the relative impacts of proposed improvements.

Another limitation of the corrected effective model, and presumably, the FEMA model as well used to develop the 2005 FIS, is the occurrence of overland flow. This is particularly true along Butcherknife Creek where one-dimensional (1D) channel flow exceeds bank full capacity and discharges onto the overbank areas, becoming two-dimensional (2D) overland flow without a defining boundary. HEC-RAS was not developed to solve 2D flow regimes and so manual interpretation of the flow boundary is required, and is based on assumed momentum caused by overland slopes, obstructions, streets, swales, etc. This may be observed by referring to Butcherknife Creek Cross Section 2.5 through Section 5.5, for the Corrected Effective Model located in Appendix D.

4.6 INITIAL PROBLEM AREA IDENTIFICATION

4.6.1 SODA CREEK

In general, Soda Creek is moderately encroached upon and routinely conveys base flows with little or no problem. Two recent bridge projects at Yahmonite Street and Pine Street have greatly increased the conveyance capacity of those structures and have improved the overall hydraulic performance of Soda Creek. These structures are clear span bridges with concrete abutments with bridge spans of 30 to 40 feet. The most notable deficiencies along Soda Creek are the hydraulic restrictions located at the culvert crossings of Lincoln Avenue, 11th Street, and Oak Street, all of which are downstream from the Yahmonite Street and Pine Street bridges. The existing culverts are undersized for the 100-year peak discharge and create sufficient backwater to overtop the banks and spill flood flows into the streets.

This study evaluates the impact of bridge improvements for Soda Creek at Lincoln Avenue, 11th Street and Oak Street.

4.6.2 BUTCHERKNIFE CREEK

The most notable deficiency along Butcherknife Creek is the residential encroachment up to the creek banks which reduces, and in most cases, eliminates the flood storage function of the overbank areas and the natural floodplain. It is not readily feasible for the City to reclaim this ground to solve the problem due to the high number of residential properties on either side of the creek banks. In addition, numerous restrictions limit bank full discharge to nearly a third of the 100-year peak discharge in some areas and once this value is exceeded, the creek begins to overtop its banks. The restrictions include road crossings, driveway crossings, and narrow channel sections. Base flows routinely result in bank full discharge, particularly in the spring during peak snowmelt runoff, and often requires sand bagging along the creek banks. Debris also becomes lodged under driveway crossings or culvert entrances and creates a flooding nuisance.

A second deficiency is the creek's alignment through the downtown portion of the study area. This reach begins at the alley between Oak Street and Lincoln Avenue and ends at Eagle Scout Park. Through this reach, Butcherknife Creek ceases to exist as an open channel and is instead conveyed

in closed stormwater pipe. The closed conduit alignment passes through private property and is under capacity in certain areas. For further discussion of this deficiency, please refer the design memorandum located under a separate cover.

This study evaluates two alternative solutions to address the capacity and frequent bank full discharge problems along the open channel portions of Butcherknife Creek and to also improve the closed stormwater pipe and road crossing configuration.

4.7 PROPOSED IMPROVEMENTS

Please refer to Section 5 and Section 6 for a detailed discussion of the proposed improvements intended to address the problem areas noted herein.

4.8 FLOOD DAMAGE ESTIMATES

A detailed analysis of flood damage is not within the scope of this Drainage Study and Floodplain Masterplan. However, a generalized discussion is provided based upon the evaluation of the existing floodplain. The FEMA regulated floodplain (effective model), as well as the corrected effective model floodplain produced as part of this study, impacts a large number of residential and commercial properties and also depicts the overtopping of local, collector and arterial roadways. Without a detailed survey of finished floor elevations, or a review of flood insurance policies, it is not possible to conclude which private properties would experience flooding within habitable structures. Based on field observations though, it does appear that numerous homes would significantly be impacted. Flood damages to private property may range from no-impact up to shallow flooding and in some cases, may include significant losses triggering a total loss.

Public facilities, including roads, bridges and culverts may experience overtopping, significant erosion and potential total failure. Total failure of public infrastructure has the potential to exacerbate other problems caused by culvert washout flood waves and impassable roadways which may reduce the City's ability to provide emergency services.

4.9 NEEDS ASSESSMENT

Based on the potential flood damages associated with the effective and corrected effective models and the desire to evaluate the potential removal of impacted properties from the floodplain, numerous needs were identified to mitigate and reduce the current flood risk potential. The goal is to improve conditions to the best extent possible by implementing sound engineering solutions. In general, the needs are encapsulated by a single premise; where possible, improve channel and structure capacity so that floodwaters are more safely conveyed downstream. After performing an on the ground investigation of Soda and Butcherknife Creeks and evaluating the hydraulic models, several alternatives were developed to alleviate the current condition. Specifically, these alternatives include improving culverts and bridge crossings so that they are capable of fully passing the 100-year flood flow. In the case of Butcherknife Creek where insufficient capacity exists along the entire corridor, providing a channel diversion to a piped system to remove a percentage of the flood flow from the channel. A detailed discussion of each of the alternatives is provided in section 6.0.

5.0 HYDRAULIC ANALYSIS OF STORM SEWER INFRASTRUCTURE

5.1 GENERAL

A hydraulic evaluation of the existing storm sewer and subsequent determination of necessary storm sewer infrastructure essential for sufficient conveyance of storm runoff was conducted within the Study Area. The hydrologic analysis and associated storm runoff quantities provided the foundation for the hydraulic evaluation. Since existing storm sewer is present within the Old Town Steamboat Springs area, a preliminary evaluation of the conveyance capacity was compiled to determine if the existing storm sewer should be improved. In addition, street capacities within the Study Area were evaluated to determine proposed storm sewer. The subsequent sections detail the assumptions, approach and analyses conducted to evaluate the storm sewer.

It should be noted that final design for road and drainage improvements to Lincoln Avenue is being completed under a separate CDOT contract (by others) at the time of this study. CDOT and the City are currently preparing construction plans that include upgrades / modification to the local drainage systems that were not part of this Final Draft of the Old Town Drainage Study. However, recommendations provided herein were made available to the Lincoln Avenue design team.

5.2 HYDRAULIC CRITERIA

According to the *City of Steamboat Springs Engineering Standards* the major storm shall be the 100-year recurrence interval storm and the minor storm shall be the 5-year recurrence interval storm. The 5-year storm was utilized for conveyance of nuisance flows, determination of storm sewer conveyance, and evaluation of street capacities. Once street capacities were exceeded during the 5-year event, storm sewer was added to assist with conveyance. This concept and approach would satisfy and address the expressed concerns of City staff regarding nuisance flows and problematic areas throughout the Study Area.

Due to the limitations of the 2-foot contours for determining roadway cross sections, it was assumed that each street included a ditch section unless curb and gutter was currently present. This assumption allows standard curb and gutter street capacity curves for local streets to be utilized. Analysis of curb and gutter street flows and ditch capacities were evaluated and inlets were added where street capacities are anticipated to be exceeded or in areas of sump. Allowable street capacities were obtained based on street type and street slope the City of Steamboat Engineering Standards criteria. The street capacities were evaluated for the minor (5-Year). Where street capacities were exceeded, an inlet was added to capture and reduce surface runoff. For purposes of preliminary design, inlet configurations and types are not specified due to the limited survey data. The need for more detailed information will be necessary for final design to capture the minor storm event for specific topographic constraints such as street slope, location, and configuration.

Once street capacities were exceeded, the full 5-year event was assumed to be conveyed within storm sewer. Preliminary storm sewer and inlet sizes were calculated for this study. Inlets were estimated to capture the full minor storm event. Due to the limited survey detail and preliminary nature of the project, final design and configuration of the storm sewer is required. The sizes and alignments are provided for planning and conceptual purposes.

The preliminary size of the storm sewer was estimated using Equation 5.9.2 of the City of Steamboat Springs Engineering Standards. The initial pipe size, D_i, is based on the peak design flow (Q_p) and pipe slope (S_o) and is estimated by the following equation:

$$D_i = \left[\frac{2.16 n Q_p}{S_o^{1/2}} \right]^{3/8}$$

Where: n = Manning's Roughness Coefficient
Q_p = Peak Design Flow (cfs)
S_o = Pipe Slope (ft/ft)

For purposes of the conceptual design and analysis, the preliminary size calculation utilized a pipe slope parallel to the controlling street slope.

Open channel flow calculations were required to size swales, emergency overflows, spillways, and channels. Calculations were performed using Manning's Equation and FlowMaster and are provided in the Appendix for review. A Hydrologic Engineering Center River Analysis System (HEC-RAS) model was compiled for both Soda and Butcherknife Creeks and portions of the models completed are provided in the Appendix of this report. Design of the culverts, outlet protection and walls were designed according to Urban Drainage and Flood Control Districts (UDFCD) Urban Storm Drainage Criteria Manual (USDCM) Volumes 1 and 2 (Reference 12). Culvert analysis was completed using CulvertMaster (Reference 14).

5.3 EVALUATION OF EXISTING CONDITIONS

Utilizing estimated existing street capacities and the 5-year recurrence storm interval, it was determine that storm sewer in the upper reaches was necessary to safely convey runoff.

Based on correspondence and field visits with City staff, areas of local flooding, inadequate conveyance and nuisance flows were identified. Several of these locations are discussed in Section 3 and the hydrologic and subsequent hydraulic analyses confirm the City's observations.

5.4 PROPOSED STORM SEWER DESIGN

Due to nuisance flooding and street flooding, additional storm sewer infrastructure is proposed in the Soda Creek and Butcherknife Creek tributary basins. Upsizing of existing storm sewer within the Soda and Butcherknife Creeks and the Direct Flow Area to the Yampa River was necessary based on the hydraulic evaluation. All storm sewer pipe diameters were preliminarily sized to convey the full 5-year storm event unless noted otherwise. Please note that there are areas (such as 11th Street near Bob Adams drive) that experience natural springs and seeps. While this study does not specifically address those areas, mitigating these areas should be a consideration when implementing future storm sewer systems.

Please refer to the Appendix for the storm sewer exhibit. A description of the significant improvements is discussed below:

5.4.1 SODA CREEK

Five (5) storm laterals are proposed for Soda Creek. The addition of these laterals is directly attributable to street capacities being exceeded in the upper regions of the watershed and the need to

address localized areas of nuisance flows. A description of the storm laterals for the Soda Creek basin area are described below:

- SO - STORM LATERAL 1
  Street capacity is exceeded at the intersection of Bob Adams Drive and The Boulevard at Design Point SO-C3. Therefore, storm sewer was extended to the location for necessary inlets. Inlets were added along the storm sewer lateral to capture additional surface flow since the presence of the storm was established. SO – Storm Lateral 1 will discharge into Soda Creek upstream of bridge/culvert located at Lincoln Avenue.

- SO – STORM LATERAL 2
  Street capacity is exceeded for the tributary area along Oak Street. SO – Lateral 2 extends from Soda Creek to 8th Street. The lateral was extended northeast along 8th Street to a proposed inlet near the church to capture and convey the discharge from a sump pump. Groundwater causes a nuisance surface flow that began at this location and persisted along Oak Street to Soda Creek. Several existing inlets and roadside ditches were present along Oak Street. The existing inlets will be connected to the proposed line and it is recommended that the road side ditches remain in place to convey snowmelt runoff and portions the 100-year storm event.

- SO - STORM LATERAL 3
  Street capacity is exceeded higher in this basin at the intersection of Thornberg Street and Uncochief Street at Design Point SO-B3. Therefore, storm sewer was extended to the location for necessary inlets. Several areas along Yahmonite Road were identified as problematic with localized flooding and nuisance flows. As a result, inlets were added along the storm sewer lateral to capture additional surface flow and help minimize the problematic nuisance flows. The existing roadside ditches are recommended to remain in place to convey the 100-year storm event. SO – Storm Lateral 3 will discharge into Soda Creek directly downstream of Yahmonite Bridge.

- SO – STORM LATERAL 4
  At design point SO-F1, which is located at the intersection of Broad Street and Nob Street, street capacity is exceeded. Existing inlets were present at this location and an existing storm sewer lateral conveys flow past the school to Soda Creek. At the time of the draft report, the existing storm sewer size was unknown. Verification of the existing storm sewer size is necessary.

- SO – STORM LATERAL 5
  SO - Storm Lateral 5 comprises of the storm sewer alignment along Lincoln Avenue. An existing storm line conveys flow but is inadequate for the design storm and required upsizing. The outfall of Storm Lateral 5 into Soda Creek is downstream of the bridge/culvert crossing under Lincoln Avenue.

5.4.2 BUTCHERKNIFE CREEK

At this current time, no storm sewer laterals are recommended within the Butcherknife Creek basin. However, a possible diversion along Butcherknife Creek to reduce the peak flood event within the main channel corridor is discussed in Section 5.0 – Alternatives Development and Evaluation for Butcherknife Creek. Based on a potential alternative, if a discharge of 200 cfs is conveyed with diversion pipe the recommended pipe diameter is 60-inches.

5.4.3 SPRING CREEK

At present no storm sewer laterals are recommended within Spring Creek. Within the Study Area, the tributary areas of Spring Creek tend to directly flow into Spring Creek; therefore, street capacities are not exceeded. Existing storm lines were identified within the watershed.

5.4.4 DFA – YAMPA

Existing storm sewer infrastructure conveys the majority of runoff from the Direct Flow Areas to the Yampa River in Old Town. Several discharge points were identified along the Yampa River. Analysis of the infrastructure indicated several of the existing storm laterals were undersized. Therefore, recommendations for increasing the pipe diameter were provided. Increasing the pipe diameters will dramatically improve problematic drainage areas and minimize nuisance flows.

Specifically, these improvements comprise of:

- Increasing the storm sewer at the intersection of 12th Street and Yampa Street
- Adding an inlet for local nuisance drainage at the southeast corner of the intersection of 11th Street and Yampa Street
- Eliminating the outfall under the Steamboat Yacht Club by connecting it to and upsizing the storm outfall along 9th Street
- Increasing size of the existing storm sewer along 9th Avenue between Lincoln Avenue and the alley to the northeast
- Increasing the storm sewer and outfall along 6th Street from Yampa Street to the outfall at the Yampa River
- Increasing the existing storm sewer along 5th Street from the outfall into the Yampa River to Pine Street.
- Consolidating and reducing the number of outfalls into the Yampa River

6.0 ALTERNATIVES DEVELOPMENT AND EVALUATION FOR BUTCHERKNIFE CREEK

6.1 GENERAL

Of the three major drainageways traversing the Study Area, Butcherknife Creek was the most problematic. The existing hydraulics along Butcherknife Creek are negatively impacted by a limited main channel corridor, undersized culvert crossings, extensive flooding caused by obstructions, a wide, flat, ill-defined floodplain, and the inability of runoff to return to the channel once it overtops the main channel corridor banks. Snowmelt and spring runoff also cause nuisance flooding on a yearly basis and consequently, restoration and maintenance is typically completed by the City to mitigate impacted areas. In addition, residential structures closely encroach upon the channel corridor. Individually and collectively, each of these factors is the cause for developing possible design alternatives to minimize potential flooding damages and reduce overall flooding.

6.2 ALTERNATIVES DEVELOPMENT

Several alternatives were developed and assessed for the Butcherknife stream corridor. The alternatives were established to sustain the principles and significance of the riparian corridor and to reduce the flooding potential to the surrounding community. The corrected effective hydraulic model and proposed conditions hydraulic model are the basis of analysis and comparison for recommended improvements. It should be noted that each hydraulic model and the ability to evaluate the proposed improvements is limited by the level of detail used to create each. As noted previously, existing structures were modeled without the benefit of a detailed survey. The implementation of several alternatives will require a significant capital investment, and therefore, final design should include a detailed survey and hydraulic analysis. It may be possible to downsize the structures recommended herein with more detailed input. Additionally, the improvements which reduce the extent of the floodplain will require an official FEMA Letter of Map Revision if the City wishes to formally recognize the improvements and take credit for them within the National Flood Insurance Program (NFIP).

Specifically, the alternative goals include:

- Establish adequate floodplain improvements to “preserve and promote the general health, welfare, and economic well-being of an area” by:
    - Reducing risk of loss of life and property damage
    - Protecting hydraulic characteristics of water courses
    - Reducing public expenditures for flood control and relief
- Balance drainageway and stream stability improvements with floodplain concerns such as stream geomorphology and riparian habitat
- Minimize the stream instability, degradation, or aggradation
- Maintaining the sense of community and rural values
- Consideration of roadway crossings

Based on correspondence with City of Steamboat Springs representatives and utilization of the information discovered as part of this study, the six alternatives developed were:

- Alternative A: No Action
- Alternative B: Minimal Channel Improvements and Protect Critical Locations
- Alternative C: Complete Channel Stabilization for Conveyance
- Alternative D: Conveyance of a portion of storm and snowmelt runoff in a large diameter pipe paralleling Butcherknife <u>without</u> road crossing culvert improvements
- Alternative E: Conveyance of a portion of storm and snowmelt runoff in a large diameter pipe paralleling Butcherknife <u>with</u> road crossing culvert improvements
- Alternative F: Diversion of a portion of storm and snowmelt runoff in a large diameter pipe to Soda Creek
-

6.3 EVALUATION CRITERIA

Certain factors for consideration when evaluating the Alternatives were developed. The following principles were considered when evaluating the alternatives

- Operation and Maintenance
- Construction Costs
- Implementation
- Constructability
- Flood Control
- Erosion Control
- Land Use
- Impacts to Property Owners and Community
- Legal and Institutional Frameworks

6.4 IMPACT ASSESSMENT

The Old Town Steamboat Springs Area is unique having three major drainageways as well as a major river that form its boundary. The Yampa River is vital to Steamboat and provides a large recreational amenity. The stream corridors not only provide conveyance for runoff. There is also an environmental stewardship and importance placed on these systems by citizens and the City of Steamboat Springs. Understanding how the alternatives impact the stream corridors from a water quality, environmental and floodplain is vital.

6.5 ALTERNATIVES EVALUATION

With the aforementioned discussion of the alternatives and associated guidelines of the project, the following section provides a detailed description of the Alternatives and identifies advantages and disadvantages of each.

a. Alternative A - No Action

This alternative does not include any improvements and assumes that the existing channel corridor is left "as-is" and that no stream modifications would occur. The major shortcoming with this approach is that the localized areas of erosion and channel instability will continue and there is no reduction in flood risk. Therefore, this alternative was provided as a baseline situation that other alternatives could be compared to.

i. Advantages

- Low capital costs
- No construction permitting will be required
- No construction disturbance

ii. Disadvantages

- Continued stream degradation of the channel corridor and banks
- Important structures such as the culvert crossing could be impacted
- Nuisance flows and spring snowmelt will continue to adversely impact the stream corridor, residents and structures
- High operation and maintenance costs
- Stakeholder and public opinion of this alternative may be negative
- Risk for damage to property, infrastructure, and environmental is not reduced or minimized
- Does not sustain the principles and significance placed on riparian corridor, reduction in the risk to loss of life and property damage, and reducing the long term public expenditures identified in the Alternative Development

b. Alternative B - Minimal Channel Improvements and Protect Critical Locations

This alternative allows the minimal improvements to protect crucial locations from additional flooding damage. In general, this alternative consists of:

- Floodproofing at selected crossings by increasing culvert capacities and providing adequate hydraulic conveyance for the designated design storms.
- Rehabilitating existing erosion and armoring against future erosion that has developed directly upstream and downstream of culverts by installing traditional riprap.

i. Advantages

- Flood protection of critical areas
- The existing culverts, which were hydraulically limited and caused backwater that lead to additional flooding, are improved to provide better conveyance capacity.
- Small reduction in the floodplain
- Minimal initial capital costs to implement
- Adheres to portions of the principles and significance placed on riparian corridor identified in the Alternative Development

ii. Disadvantages

- Channel conveyance capacity is still very limited. Therefore, higher snowmelt or storm recurrence intervals will not be contained within the banks under this condition. A major reason for the wide shallow floodplain is that runoff has difficulty getting back into the main channel once outside the banks due to topographic constraints and structural obstructions such as buildings and fences.
- Continued shallow flooding will persist due to the insufficient channel conveyance
- Extremely difficult to provide the adequate culvert capacity due to limited width and available head
- Although there will be a small localized reduction in the floodplain, the risk to property damage and loss to life is not substantially reduced
- Construction and Environmental permitting will be required. The environmental permitting can be time consuming, labor intensive and costly
- Moderate operation and maintenance costs
- A reactive approach so continual monitoring of channel stability is required. Funds should be planned for and made available for continual remediation

c. Alternative C - Complete Channel Stabilization for Conveyance

This alternative allows for all improvements necessary to remove crucial locations from additional flooding damage and to provide full conveyance with the main channel of the drainageway. It is important to note that the constraints of Butcherknife Creek limit the ability to produce a truly natural stream corridor without significant modifications and property acquisition. The feasibility of restoring the channel to a historic state is unrealistic. Therefore, it was deemed that providing the necessary capacity within the main channel while attempting to minimize flooding outside the banks and within the historic floodplain was the most feasible scenario for this alternative. However, this alternative is logistically difficult and cost prohibitive but was valuable for comparing it to other alternatives. In general, this alternative consists of:

- Floodproofing of selected crossings by increasing culverts capacities and providing adequate hydraulic conveyance for the designated design storms.
- Rehabilitating existing erosion and armoring against future erosion that has developed directly upstream and downstream of culverts by installing traditional riprap.
- Grading the main channel corridor to provide adequate conveyance capacity of the baseflow and 100-year peak runoff event.

Ideally, Butcherknife Creek would have a wide, natural, vegetated floodplain and the main channel corridor would convey the bankfull discharge, which approximately occurs every 1.5 years (67% probability occurring within a year). However, since the existing main channel along Butcherknife is a narrow, restricted and limited hydraulically, the main channel corridor was determined to be the most important component to convey the full 100-year event. To achieve reduction of the floodplain and to provide full conveyance of the 100-year flood event within the channel corridor, Alternative C assumes complete reconstruction of the channel by regrading, vegetating and providing grade control structures.

i. Advantages

- Flood protection of critical areas
- Channel stabilized for conveyance of flows
- Reduced (but not eliminated) liability to the property and infrastructure
- Adheres to the principles and significance placed on riparian corridor identified in the Alternative Development

ii. Disadvantages

- High capital costs
- High environmental impacts due to reconstruction of the entire stream corridor
- Improvements are on private property with no easements currently provided

- Property acquisition will be necessary
- Construction will impact property owners along the stream corridor and will require temporary access and construction agreements
- Public opinion of this alternative will likely be negative due to the property modifications/acquisitions and inconvenience due to construction.
- Substantial construction permitting will be required

d. *ALTERNATIVE D - Conveyance of a Portion of Storm and Snowmelt Runoff in a Large Diameter Pipe Paralleling Butcherknife Creek without Road Crossing Culvert Improvements*

Due to the limited conveyance capacity in the existing channel corridor and the extreme difficulty of meeting the principles established for the stream corridor above, Alternative D was created to reduce the flooding created by higher storm events while maintaining a baseflow within Butcherknife Creek. This alternative includes a piped diversion but does not include capacity improvements to culverts at road crossings. In general, this alternative consists of:

- Diverting 200 cfs from the peak storm and snowmelt runoff events. The hydrology of Butcherknife Creek reported in the 2005 FIS indicates 325 cfs for the 100-year peak flow; therefore, a reduction in the 100-year flow in the existing channel would be decreased to 125 cfs.
- The diversion would occur within City of Steamboat Springs designated open space at Stehley Park. Preliminary design would require grading and an in-channel diversion structure.
- The 200 cfs would be conveyed in a 60-inch RCP that traverses along Missouri Avenue to 7th Avenue. The City specifics CMP, but due to the large diameter of this diversion pipe, it was assumed that RCP would be utilized due to its increased hydraulic performance and longer lifespan. A price competitive alternative may include steel reinforced HDPE, which combines many of the distinct benefit found in RCP.
- Near the intersection of 7th Avenue and Oak Street, the diversion would be increased to a 4-foot high by 8-foot wide reinforced concrete box culvert for the recombined full flow along Butcherknife Creek.

i. ADVANTAGES

- Reduction in floodplain with minimal disturbance to properties and the existing stream corridor.
- Reduction in the risk of life and property damage along Butcherknife Creek.
- Diversion and associated storm sewer are located within the City of Steamboat Springs open space or right-of-way.
- A baseflow will continue to be present in the main channel corridor providing necessary flow for aquatic and riparian habitat while supplying a flow for property owners along the existing corridor.
- Diversion pipe provides a main trunk line for smaller drainage basins to utilize for conveyance.
- Construction permitting and environmental acceptance from the governing agencies may be easier to obtain.
- Reduced long-term operation and maintenance costs
- Adheres to the principles and significance placed on riparian corridor identified in the Alternative Development

ii. DISADVANTAGES

- Some of the existing culverts and driveway crossings are still hydraulically inadequate and cause localized areas of flooding during a peak event. The hydraulic model produced localized floodplain improvements but the overtopping of several roadways does persist.
- Public safety and emergency response remains an issue due to overtopping roadways.
- Cost
- Constructability
- Potential impact to existing utilities within the right-of-way

e. *ALTERNATIVE E - Conveyance of a Portion of Storm and Snowmelt Runoff in a Large Diameter Pipe Paralleling Butcherknife Creek with Road Crossing Culvert Improvements*

Due to the limited impact of Alternative D alone, Alternative E is provided to incorporate culvert improvements to improve the overall conveyance capacity within the existing channel corridor and to eliminate the overtopping of roadways. This alternative builds upon the piped diversion by incorporating capacity improvements to culverts at road crossings. In general, this alternative consists of:

- Diverting 200 cfs from the peak storm and snowmelt runoff events. The hydrology of Butcherknife Creek reported in the 2005 FIS indicates 325 cfs for the 100-year peak flow; therefore, a reduction in the 100-year flow in the existing channel would be decreased to 125 cfs.
- The diversion would occur within City of Steamboat Springs designated open space at Stehley Park. Preliminary design would require grading and an in-channel diversion structure.
- The 200 cfs would be conveyed in a 60-inch RCP that traverses along Missouri Avenue to 7th Avenue. Near the intersection of 7th Avenue and Oak Street, the diversion would be increased to a 4-foot high by 8-foot wide reinforced concrete box culvert for the recombined full flow along Butcherknife Creek.
- Capacity improvements to existing roadway culverts at Oak Street, Pine Street, Short Street, Butcherknife Alley and Spruce Street.

i. ADVANTAGES

- Reduction in floodplain with minimal disturbance to properties and the existing stream corridor
- Reduction in the risk of life and property damage along Butcherknife Creek.
- Diversion and associated storm sewer are located within the City of Steamboat Springs open space or right-of-way
- A baseflow will continue to be present in the main channel corridor providing necessary flow for aquatic and riparian habitat while supplying a flow for property owners along the existing corridor
- Diversion pipe provides a main trunk line for smaller drainage basins to utilize for conveyance
- Construction permitting and environmental acceptance from the governing agencies may be easier to obtain
- Reduced long-term operation and maintenance costs
- Adheres to the principles and significance placed on riparian corridor identified in the Alternative Development

ii. DISADVANTAGES

- Cost
- Constructability
- Property acquisition

- Potential impact to existing utilities within the right-of-way

f. *ALTERNATIVE F - Diversion of a Portion of Storm and Snowmelt Runoff in a Large Diameter Pipe to Soda Creek*

Similar to Alternatives D and E, an option was conceived to do a basin transfer of flow from Butcherknife Creek to Soda Creek. In general, the alternative consists of:

- Diverting 200 cfs from the peak storm and snowmelt runoff events. The hydrology of Butcherknife Creek reported in the 2005 FIS indicates 325 cfs for the 100-year peak flow; therefore, a reduction in the 100-year flow in the existing channel would be decreased to 125 cfs.
- The diversion would occur within City designated open space at Stehley Park. Preliminary design would require grading and an in-channel diversion structure.
- The 200 cfs would be conveyed in a 60-inch RCP that traverses along Missouri Avenue to Laurel Street. At Laurel Street, the storm sewer would flow north towards Crawford Avenue and then ultimately to Soda Creek along Crawford Avenue.

i. ADVANTAGES

- Reduction in floodplain with minimal disturbance to properties and the existing stream corridor
- Reduction in the risk of life and property damage along Butcherknife Creek.
- Diversion and associated storm sewer are located within the City of Steamboat Springs open space or right-of-way
- A baseflow will continue to be present in the main channel corridor providing necessary flow for aquatic and riparian habitat while supplying a flow for property owners along the existing corridor
- Diversion pipe provides a main trunk line for smaller drainage basins to utilize for conveyance
- Required pipe length is decreased when compared to Alternative D and E.
- Construction permitting and environmental acceptance from the governing agencies may be easier to obtain
- Reduced long-term operation and maintenance costs
- Adheres to the principles and significance placed on riparian corridor identified in the Alternative Development

ii. DISADVANTAGES

- Culvert and bridge crossings would need to pass the additional 200 cfs. The two redeveloped bridges at Pine and Yahmonite, which were recently (or currently under) constructed and designed to pass a 100-year event of 1300 cfs would now be under designed. Downstream at Lincoln Avenue, 11th Street and Oak Street where the ability to place a large enough culvert/bridge to pass a 100-year event is difficult, the additional 200 cfs compounds that problem
- Transferring the flood risk associated with Butcherknife Creek to Soda Creek
- Increases the limits of flooding within the Soda Creek basin
- Requires a basin transfer. Basin transfers, even for flooding events, may be difficult to promote to the public
- Potential impact to existing utilities within the right-of-way

6.6 CONCLUSION

Based on the options presented above, Alternative E was selected for final analysis based on the limited conveyance capacity of the Butcherknife Creek channel and the difficulty to improve conveyance. This difficulty is caused by existing encroachment and the severe ramifications to property owners that would occur during channel modification, significant costs, and the overall difficulty in achieving an in-stream solution. Additional discussion of the conceptual design is provided in Section 7.3 – Butcherknife Creek Conceptual Design.

7.0 CONCEPTUAL DESIGN OF CHANNEL IMPROVEMENTS

7.1 GENERAL

After evaluating the hydrology, hydraulics and alternatives, a recommended design for the Old Town Steamboat Area was developed. The preliminary design addresses the modifications necessary within the Soda, Butcherknife and Spring Creek drainageways and storm sewer improvements to convey the minor storm event. The Masterplan assists the City of Steamboat Spring with long-term planning of infrastructure

7.2 SODA CREEK CONCEPTUAL DESIGN

As discussed in Sections 3.6 and 4.9, improvements to Soda Creek are intended to improve conveyance capacity at several notable locations. Specifically, those locations are the Lincoln Avenue Bridge, and the culverts at the intersection of 11th Street and Oak Street. Numerous sizes were evaluated to eliminate the overtopping of the roadways and an incremental analysis showed almost no improvement for moderate capacity upgrades. Upstream improvements at the Yahmonite Street Bridge and Pine Street Bridge include bridge spans of 30 to 40 feet. Specifically, the Yahmonite Street Bridge is a clear span bridge structure with a hydraulic opening width of approximately 32 feet. The corrected effective hydraulic model shows that structure to be adequately sized. Therefore, the general size and configuration of this structure is duplicated for the conceptual design and analysis at Lincoln Avenue and the two culvert crossings at 11th Street and Oak Street. As should be expected, the proposed conditions hydraulic analysis confirms sufficient hydraulic capacity to eliminate the overtopping of each roadway. The floodplain exhibit located in the Appendix shows the net floodplain reduction to the Soda Creek floodplain as a result of the bridge and culvert improvements. The exhibit depicts localized floodplain reductions along Soda Creek around the bridges with little to no improvements along the remainder of the reach. The primary benefit resulting from these improvements is the elimination of roadway overtopping and any associated scour.

7.3 BUTCHERKNIFE CREEK CONCEPTUAL DESIGN

As discussed in Sections 4.6 and 4.9, improvements to Butcherknife Creek are intended to improve conveyance capacity along the entire channel reach. The alternatives evaluation discussed in Section 6.5 provides the basis for preliminary design and specifically, Alternatives D and E are both evaluated specifically to reduce flooding impacts along Butcherknife Creek. The hydraulic model was first revised to reflect a 200 cfs diversion at the upstream limits near Missouri Avenue. This reduced the design flow to 125 cfs along Butcherknife Creek. The floodplain exhibit located in the Appendix shows the net floodplain reduction to Butcherknife Creek as a result of the diversion. Comparing the corrected effective and proposed conditions floodplains shows modest improvement but significant roadway overtopping persists.

The hydraulic model was further modified to provide culvert improvements at Oak Street, Pine Street, Short Street, Butcherknife Alley and Spruce Street consisting of three barrel ~ 36" culvert crossings, or two barrel 6' (w) x 3' (h) RCBC in the case of Short Street. It is difficult to develop sufficient headwater along Butcherknife Creek at these locations and so a low water configuration is required. As such, minor grading may also be required along the right bank of Butcherknife Creek upstream of Short Street so that sufficient head is developed. Conceptual grading in the proposed conditions model includes approximately six to twelve additional inches of embankment along the right stream bank. The floodplain exhibit located in the Appendix shows the net floodplain reduction to Butcherknife Creek as a result of the diversion and culvert improvements. Comparing the corrected effective and proposed conditions floodplains shows significant improvements and the roadway overtopping is fully eliminated. The primary benefit to these improvements is the significant reduction of homes within the floodplain, the elimination of roadway overtopping, and the reduction of associated flood damage that occurs when a channel overtops its banks. Again, it should be noted that final design of any of these improvements should include a detailed hydraulic investigation incorporating detailed survey information.

7.4 CHALLENGES

One challenge with the preliminary design is developing a configuration that fits within available physical limits, including available cover, channel width, utilities, community character, etc. Every attempt was made to propose solutions that are conceptually feasible. However, final design may reveal constraints which will require a modification to the preliminary design. In these instances, structures should be designed with an equivalent hydraulic capacity to the best extent possible as provided herein. For example, a 32 foot clear span bridge at 11th Street will likely require property acquisition and even then, may be difficult to construct due to the tight configuration. A better option may be to construct a 32 foot large diameter arch culvert. This would change structure hydraulics and would need to be investigated. Another option is to lower the channel to develop more head and reduce the span dimension. Additionally, downstream improvements to widen the channel so that bridge abutments can be constructed would be required.

Another challenge as mentioned earlier is overall accuracy in the corrected effective and proposed conditions hydraulic models. Existing structures were modeled without the benefit of detailed survey and so the resultant water surface profile may have differed from a more detailed model. However, it does appear that the corrected effective model is accurately reflecting the overtopping of roadways, but the exact depth is difficult to determine without additional detail. Furthermore, recommended improvements may need to be downsized or upsized to optimize hydraulic performance.

Utility coordination needs to be completed with the final design of the infrastructure. Several utilities with differing service owners are present within the Study Area. Those utilities include water, sanitary and storm infrastructure maintained and operated by the City. Dry utilities such as electric, gas, and phone were not included in the coordination. Utility locations presented in this document were based on the detailed survey provided by Landmark Consultants, Inc. and the City GIS department and are approximate. Before any final design and construction activities occur, the Utility Notification Center of Colorado should be contacted to physically locate and identify utilities in the field.

7.5 COST ESTIMATES

Cost estimates for all structural improvements were determined by estimating the quantity and installation cost. Unit cost for each item was evaluated from the *2007 Colorado Department of Transportation Cost Data* (Reference 16) and current prices reflected in today's marketplace to provide reasonable estimates. However, there is considerable volatility in the economic arena and prices of materials and labor are constantly changing. Therefore, the estimate provided is conceptual in nature. Table 9 summarizes the unit prices utilized for the cost estimates:

Table 9: Unit Costs

Item	Unit	Unit Cost
18" CMP	LF	$60.00
24" CMP	LF	$88.00
30" CMP	LF	$110.00
36" CMP	LF	$130.00
42" RCP	LF	$160.00
60" RCP	LF	$220.00
24" FES	EA	$975.00
30" FES	EA	$1,050.00
36" FES	EA	$1,115.00
42" FES	EA	$3,000.00
Inlets	EA	$5,000.00
Manhole, Box Base	EA	$10,000.00
Manhole, 7' Diameter	EA	$5,000.00
Manhole, 6' Diameter	EA	$3,400.00
Manhole, 5' Diameter	EA	$2,500.00
Manhole, 4' Diameter	EA	$2,150.00
Riprap Outlet Protection	EA	$2,000.00
Connection to Existing Infrastructure	EA	$3,000.00
Heawall, Pipe Penetration	EA	$5,000.00
Diversion Structure	EA	$50,000.00
Channel Improvements	LF	$400.00
32' Wide Bridge Crossing (Lincoln Avenue)	LF	$10,000.00
32' Wide Bridge Crossing	LF	$7,500.00
4' (H) by 8' (W) RCBC	LF	$725.00
3' (H) by 6' (W) RCBC	LF	$475.00
Precast 4' (H) by 8' (W) RCBC 22.5 Bends	EA	$2,500.00
Grouted Boulder Stacked Wall Edge	LF	$125.00
Channel Riprap Outlet Protection (Lincoln Avenue)	EA	$10,000.00
Channel Riprap Outlet Protection (11th Street)	EA	$10,000.00
Channel Riprap Outlet Protection (Oak Street)	EA	$20,000.00

The cost estimate is divided into manageable segments to assist the City with prioritization of improvements as funding becomes available. The plan divides each drainageway into reaches and costs are applied per reach. Typically, reaches were defined from culvert crossing to culvert crossing unless the distance was deemed too short. Drainage improvement costs include channel restoration, culverts, storm sewer, inlets, stream stabilization measures, and a diversion. Due to the limited survey information for utilities, a 5% contingency was added to the construction costs. In addition, a 35% contingency has been added to account for administration, contingencies, legal review and engineering. Due to the difficulty in assessing land acquisition costs, right-of-way acquisition costs were excluded from the estimates and should be anticipated with some of the improvements.

Please refer to Appendix D, Figures D1 through D12 with the associated Commentary that provides a description and breakdown of the estimated costs for each portion of the Master Plan. Table 10 below summarizes the costs associated with the Master Plan.

Table 10: Master Plan Conceptual Cost Estimates

IMPROVEMENT	TOTAL ESTIMATED COST
Soda Creek Channel Improvements	$3,431,236
Butcherknife Creek Channel Improvements	$1,231,063
Butcherknife Creek Diversion	$1,159,515
SO - STM Lateral 1	$237,006
SO - STM Lateral 2	$228,898
SO - STM Lateral 3	$349,626
SO - STM Lateral 4	$576,008
SO - STM Lateral 5 with DFA-Yampa Improvements between 8th - 12th	$402,237
DFA-Yampa Improvements	$256,454
TOTAL MASTERPLAN ESTIMATED COSTS	**$7,872,043**

8.0 CONCLUSIONS AND RECOMMENDATIONS

The Old Town Drainage Study and Floodplain Masterplan for Soda, Butcherknife and Spring Creeks assesses the pressing drainage issues within the Old Town Steamboat Springs Study Area, provides basin-wide hydrologic data for the 5-year, 10-year, 25-year, and 100-year storm events and recommends proposed drainage improvements to address local flooding issues as well as 100-year.

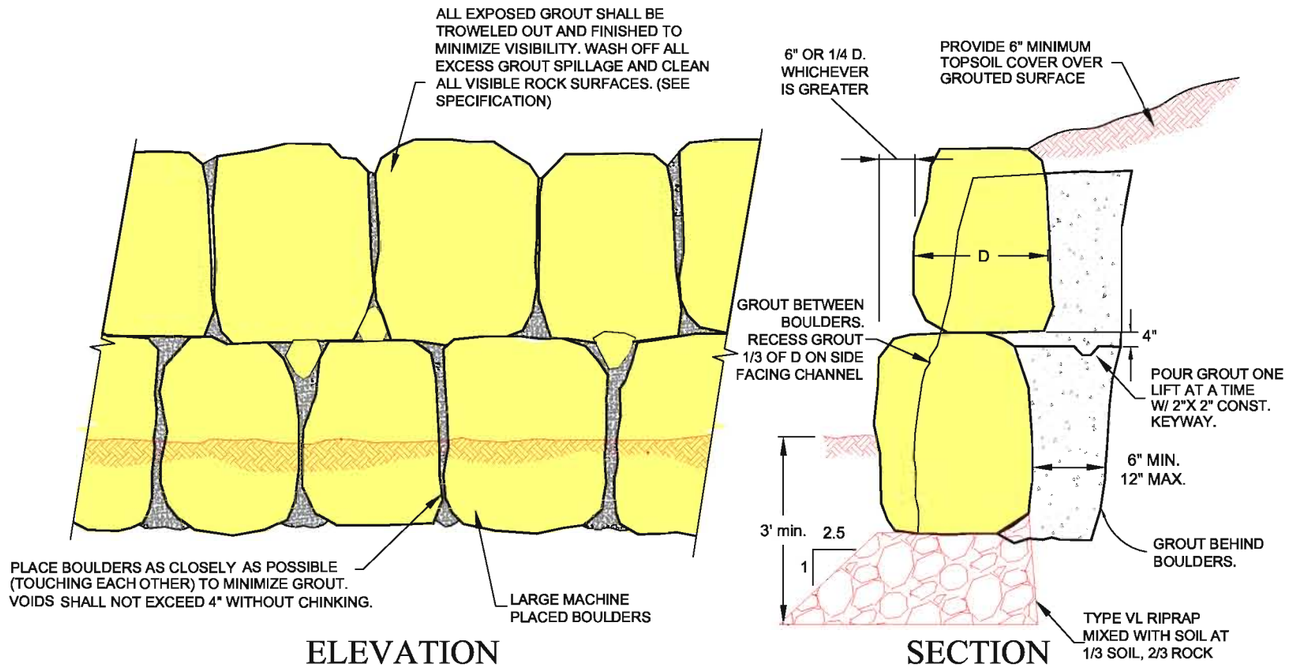
8.1 GENERAL RECOMMENDATIONS

The Old Town Drainage Study and Floodplain Masterplan for Soda, Butcherknife and Spring Creeks provides the City with a document that allows for planning and implementation of future stormwater infrastructure that will address several of the drainage problems within the area. The plan recommends stream crossing improvements within the major drainageways, a diversion for Butcherknife Creek to convey higher snowmelt runoff and peak flood events, installation of storm sewer laterals to convey flow once street capacity is exceeded, and increasing existing infrastructure to adequately convey storm events.

The following are additional recommendations:

- Inlets shown in this report are conceptually located. For the purpose of this study, inlets are located at design points where street capacity is exceeded or where a proposed storm sewer makes it convenient to add an inlet rather than conveying flows across intersections with culverts. The reader should not assume that the locations depicted or that the number of inlets shown is final. All recommended improvements shown herein will require a detailed analysis, final design, and a drainage report to be submitted to and approved by the City.
- Continue to require developers to adhere to the engineering standards established by the City for redevelopment, especially within the floodplain. Continue to promote smart, sustainable development within or adjacent to the floodplain in order to reduce risk to loss of life and property damage.
- Procure easements or the necessary right-of-way to gain access for maintenance and construction, or to sustain and promote adequate hydraulic conveyance along the stream corridors.
- Develop a program that collects stormwater impact fees which are collected as new development or redevelopment occurs within the Study Area, which help fund the public improvements necessary for implementation of the Masterplan.
- Prior to detailed design and construction documents, multiple disciplines should be consulted for valuable input necessary for sustainable channel improvements, protecting the riparian corridor, and integrating the improvements with the environment. Successful restoration projects typically require multiple disciplines including geotechnical engineers, landscape architects, biologist, wetland ecologist, etc.
- Collect detailed survey data to update the hydraulic model.
- Prepare a Conditional Letter of Map Revision Application (CLOMR) for proposed improvements in floodplains.
- Project bid items should be provided to contractors for “real” costs due to fluctuations in material, labor, and installation costs and current volatility within the overall financial environment.
- A supplemental detailed survey of the utilities such as sanitary, water, and dry utilities should occur prior to detailed construction plans.
- Minimize development and encroachment within the floodplain.

APPENDIX A:
TYPICAL DETAILS



GROUTED BOULDER STACKED WALL EDGE

GROUT NOTES

MATERIAL SPECIFICATIONS

1. ALL GROUT SHALL HAVE A MINIMUM 28-DAY COMPRESSIVE STRENGTH EQUAL TO 3200 PSI.
2. ONE CUBIC YARD OF GROUT SHALL HAVE A MINIMUM OF SIX (6) SACKS OF TYPE II PORTLAND CEMENT.
3. A MAXIMUM OF 25% TYPE F FLY ASH MAY BE SUBSTITUTED FOR THE PORTLAND CEMENT.
4. FOR TYPE A GROUT, THE AGGREGATE SHALL BE COMPRISED OF 70% NATURAL SAND (FINES) AND 30% ⅜ -INCH ROCK (COARSE).
5. FOR TYPE B GROUT, THE AGGREGATE SHALL BE COMPRISED OF ¾ -INCH MAXIMUM GRAVEL, STRUCTURAL CONCRETE AGGREGATE.
6. TYPE B GROUT SHALL BE USED IN STREAMS WITH SIGNIFICANT PERENNIAL FLOWS.
7. THE GROUT SLUMP SHALL BE 4-INCHES TO 6-INCHES.
8. AIR ENTRAINMENT SHALL BE 5.5%-7.5%.
9. TO CONTROL SHRINKAGE AND CRACKING, 1.5 POUNDS OF FIBERMESH, OR EQUIVALENT, SHALL BE USED PER CUBIC YARD OF GROUT.
10. COLOR ADDITIVE IN REQUIRED AMOUNTS SHALL BE USED WHEN SO SPECIFIED BY CONTRACT.

PLACEMENT SPECIFICATIONS

1. ALL TYPE A GROUT SHALL BE DELIVERED BY MEANS OF A LOW PRESSURE (LESS THAN 10 PSI) GROUT PUMP USING A 2-INCH DIAMETER NOZZLE.
2. ALL TYPE B GROUT SHALL BE DELIVERED BY MEANS OF A LOW PRESSURE (LESS THAN 10 PSI) CONCRETE PUMP USING A 3-INCH DIAMETER NOZZLE
3. FULL DEPTH PENETRATION OF THE GROUT INTO THE BOULDER VOIDS SHALL BE ACHIEVED BY INJECTING GROUT STARTING WITH THE NOZZLE NEAR THE BOTTOM AND RAISING IT AS GROUT FILLS, WHILE VIBRATING GROUT INTO PLACE USING A PENCIL VIBRATOR.
4. AFTER GROUT PLACEMENT, EXPOSED BOULDER FACES SHALL BE CLEANED WITH A WET BROOM.
5. ALL GROUT BETWEEN BOULDERS SHALL BE TREATED WITH A BROOM FINISH.
6. ALL FINISHED GROUT SURFACES SHALL BE SPRAYED WITH A CLEAR LIQUID MEMBRANE CURING COMPOUND AS SPECIFIED IN ASTM C-309.
7. SPECIAL PROCEDURES SHALL BE REQUIRED FOR GROUT PLACEMENT WHEN THE AIR TEMPERATURES ARE LESS THAN 40°F OR GREATER THAN 90°F. CONTRACTOR SHALL OBTAIN PRIOR APPROVAL FROM THE DESIGN ENGINEER OF THE PROCEDURES TO BE USED FOR PROTECTING THE GROUT.
8. CLEAN BOULDERS BY BRUSHING AND WASHING BEFORE GROUTING.

FIGURE HS-8: SPECIFICATIONS AND PLACEMENT INSTRUCTIONS FOR GROUT IN SLOPING BOULDER DROPS

BOULDER CHANNEL EDGE TREATMENT DETAILS

J3 Engineering Consultants Inc.
3151 S. Vaughn Way, Suite 680
Aurora, CO 80014
Tel: 303-368-5601 Fax: 303-368-5603

DESIGNED BY: JRD	DATE: 11/14/08	
DRAWN BY: JAN	DATE: 02/28/09	
CHECKED BY: KSC	DATE: 04/17/09	

CITY OF STEAMBOAT SPRINGS

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS

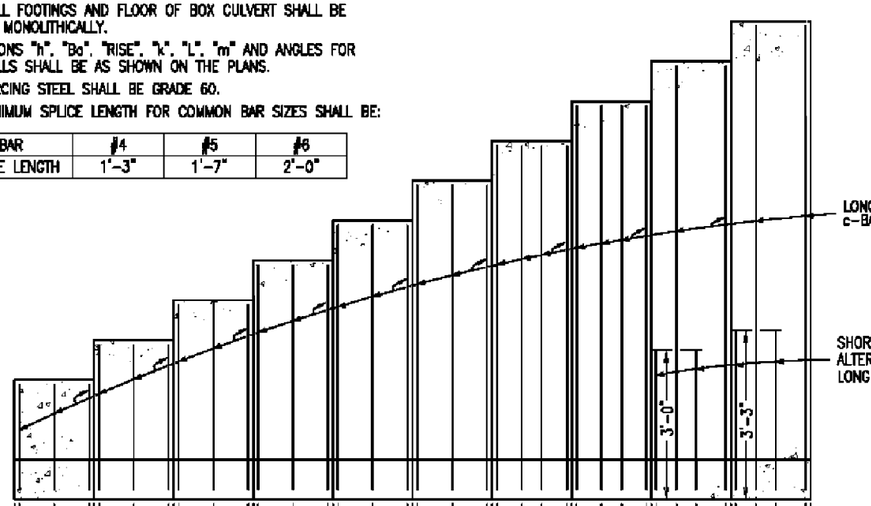
TYPICAL DETAILS

FIGURE A1

GENERAL NOTES

1. ALL EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED 3/4 IN.
2. WINGWALL FOOTINGS AND FLOOR OF BOX CULVERT SHALL BE PLACED MONOLITHICALLY.
3. DIMENSIONS "h", "Bo", "RISE", "k", "L", "m" AND ANGLES FOR WINGWALLS SHALL BE AS SHOWN ON THE PLANS.
4. REINFORCING STEEL SHALL BE GRADE 60.
5. THE MINIMUM SPLICE LENGTH FOR COMMON BAR SIZES SHALL BE:

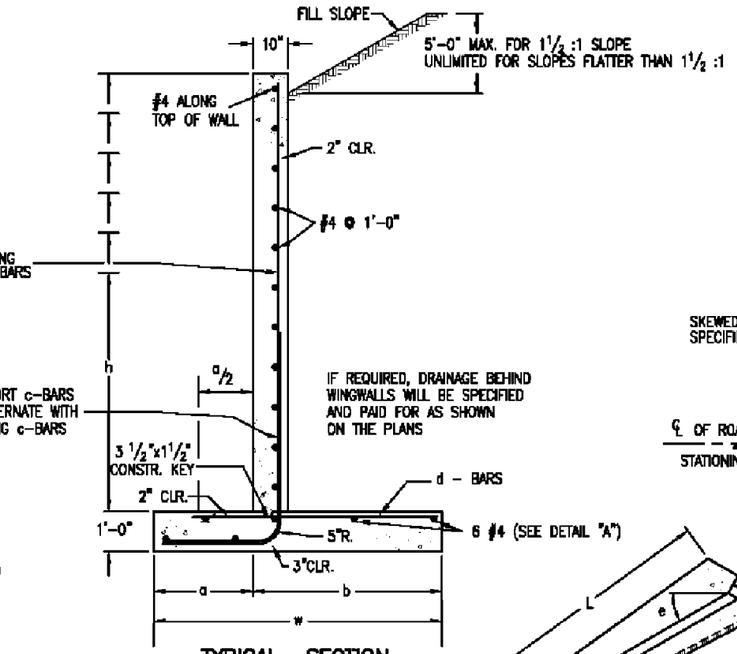
BAR	#4	#5	#6
SPLICE LENGTH	1'-3"	1'-7"	2'-0"



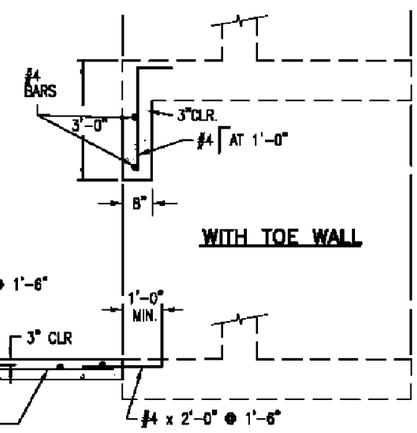
e =	1'-6"	1'-6"	1'-6"	1'-6"	1'-6"	1'-4"	1'-3"	11"	9"	7"
h =	2'	3'	4'	5'	6'	7'	8'	9'	10'	11'
a =	1'-0"	1'-2"	1'-4"	1'-6"	1'-8"	1'-10"	2'-0"	2'-2"	2'-4"	2'-6"
b =	1'-8"	2'-0"	2'-4'	2'-8'	3'-0"	3'-4"	3'-8"	4'-0"	4'-4"	4'-8"
w =	2'-8"	3'-2"	3'-8"	4'-2"	4'-8"	5'-2"	5'-8"	6'-2"	6'-8"	7'-2"
c & d BARS	#4@1'-6"	#4@1'-6"	#4@1'-6"	#4@1'-6"	#4@1'-6"	#4@1'-4"	#5@1'-3"	#5@11"	#6@9"	#6@7" CTRS.
* CONC.CU.YD./L.F.	0.161	0.210	0.259	0.308	0.358	0.407	0.457	0.506	0.556	0.604
* REINF. LB./L.F.	8.0	9.3	10.7	12.1	14.3	16.4	23.0	28.6	41.8	54.6

* DOES NOT INCLUDE TOE WALL QUANTITIES

DESIGN TABLE



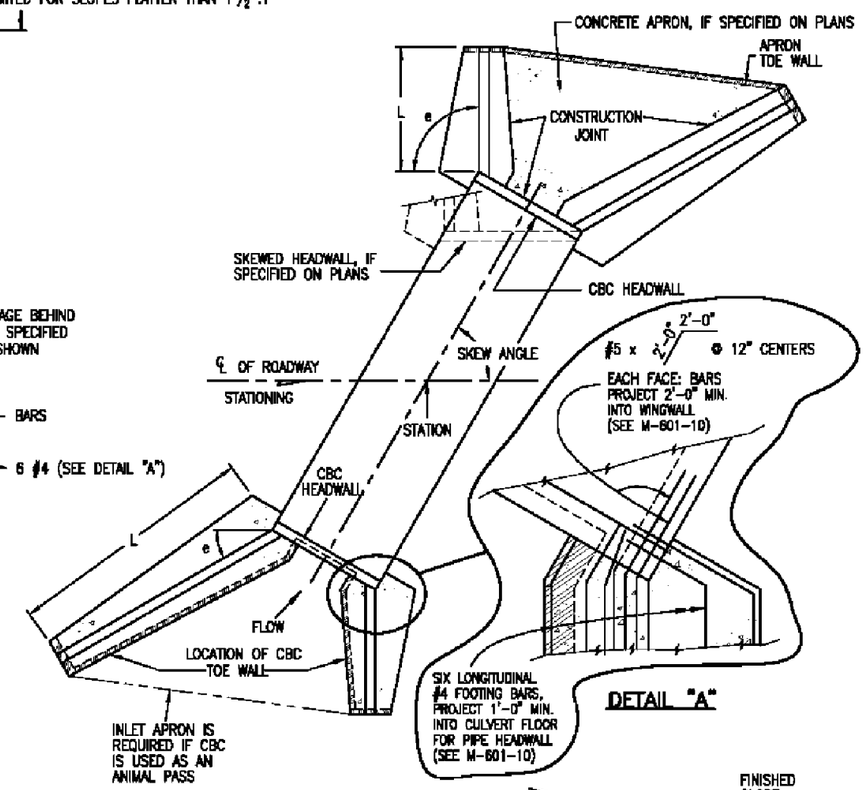
TYPICAL SECTION



WITH TOE WALL

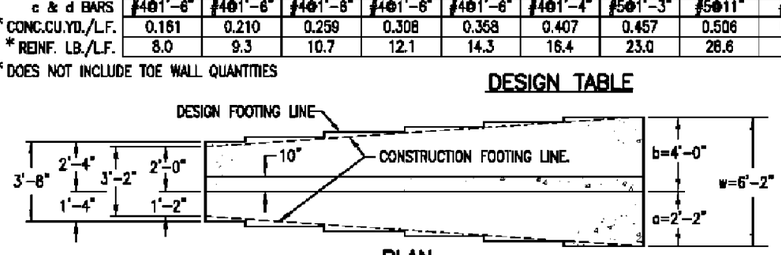
WITH CONCRETE APRON

REINFORCEMENT 0.89 LB./SQ. FT.

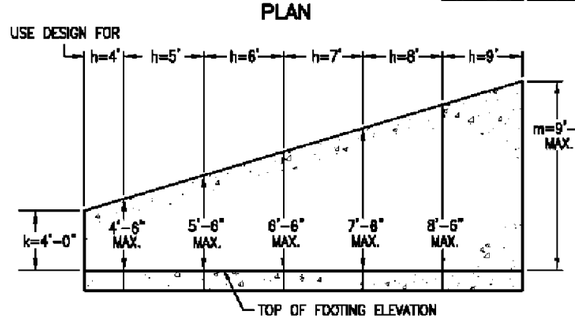


TYPICAL CULVERT LAYOUT

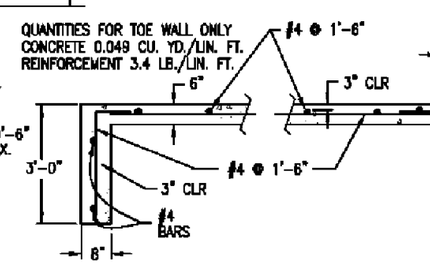
DETAIL "A"



PLAN



DESIGN EXAMPLE



APRON TOE WALL

DESIGN DATA:

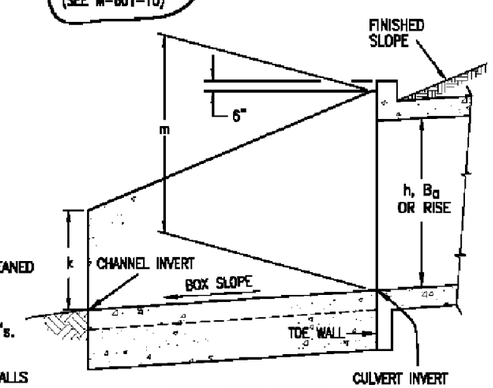
UNIT STRESSES: f_s = 24,000 PSI
f_c = 1,200 PSI
n = 9

EQUIVALENT FLUID PRESSURE = 36 LBS./CU. FT.
MAXIMUM TOE PRESSURE = 1 TON/SQ. FT.

ALL CONSTRUCTION JOINTS SHALL BE THOROUGHLY CLEANED BEFORE CONCRETE IS POURED.

WINGWALL AND APRON CONCRETE SHALL BE:
CONCRETE CLASS B, OR D (BOX CULVERT) FOR CBC's.
CONCRETE CLASS B, OR D (WALL) FOR PIPES.

LIVE LOAD SURCHARGE HAS NOT BEEN CONSIDERED. WALLS WITHIN h/2 OF THE EDGE OF THE ROADWAY SHOULDER WILL REQUIRE A SPECIAL DESIGN IN ACCORDANCE WITH AASHTO STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES.



BOX ELEVATION

m = h, Bo OR RISE + (1'-4")
UNLESS OTHERWISE SHOWN ON PLANS

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Last Modification Date: 07/04/06	Initials: LTA		
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CAD Ver.: MicroStation V8 Scale: Not to Scale Units: English			

R-X

Colorado Department of Transportation
4201 East Arkansas Avenue
Denver, Colorado 80222
Phone: (303) 757-9083
Fax: (303) 757-9820
Project Development Branch SRJ/LTA

WINGWALLS FOR PIPE OR BOX CULVERTS

Issued By: Project Development Branch on July 04, 2006

STANDARD PLAN NO.
M-601-20
Sheet No. 1 of 1

J3 Engineering Consultants Inc.
3151 S. Vaughn Way, Suite 680
Aurora, CO 80014
Tel: 303-368-5601 Fax: 303-368-5603

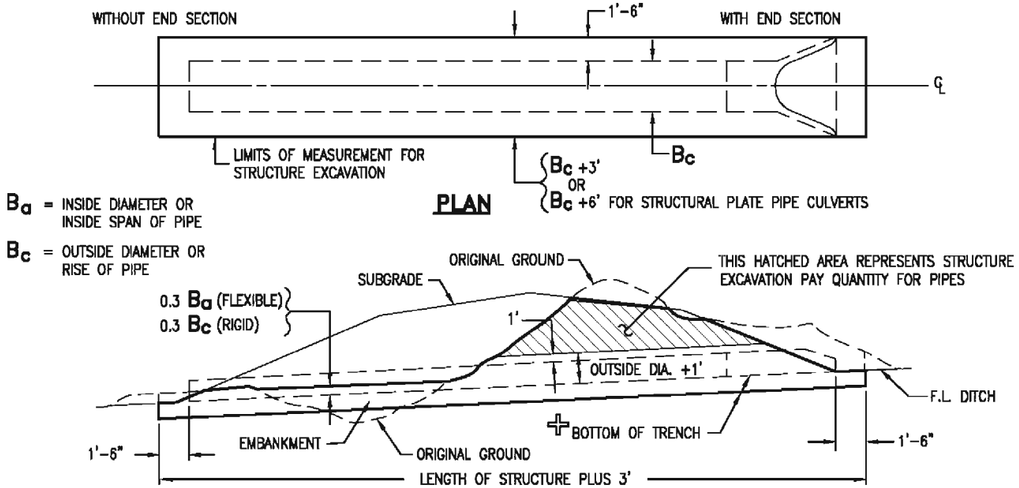
DESIGNED BY: JRD DATE: 11/14/08
DRAWN BY: JAN DATE: 02/28/09
CHECKED BY: KSC DATE: 04/17/09

CITY OF STEAMBOAT SPRINGS

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS

TYPICAL DETAILS

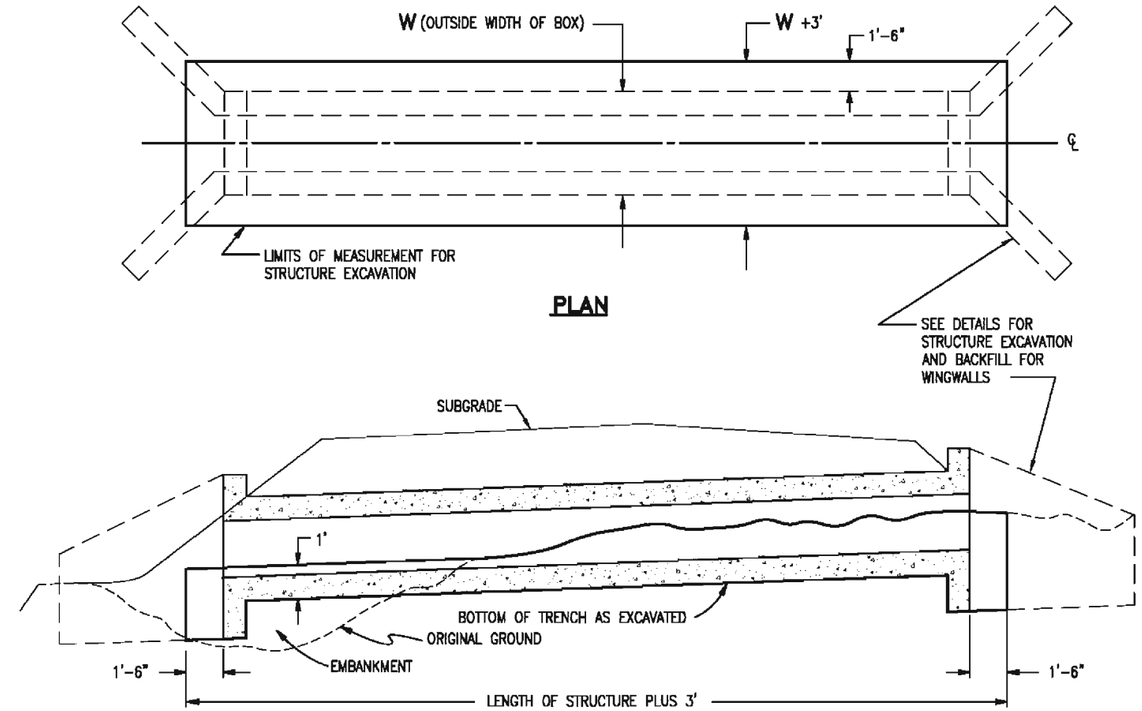
FIGURE A2



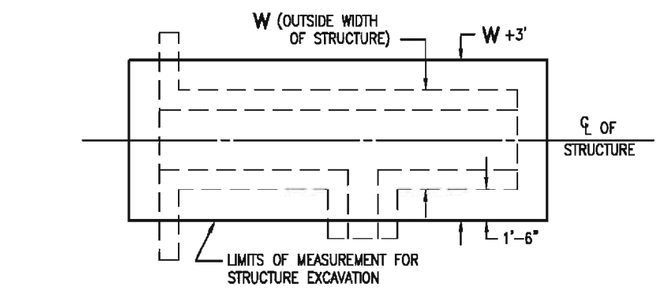
✠ FOR APPLICABLE LIMITS OF STRUCTURE EXCAVATION, SEE BEDDING DETAILS ON SHEET 1 OF THESE DETAILS.

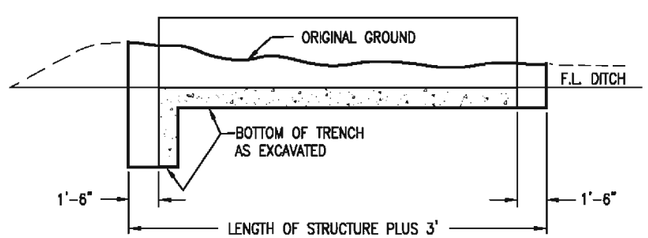
STRUCTURE EXCAVATION UP TO 1 FT. ABOVE THE TOP OF THE PIPE SHALL BE INCLUDED IN THE BID PRICE OF THE PIPE.

STRUCTURE EXCAVATION MEASUREMENT FOR PIPE CULVERTS

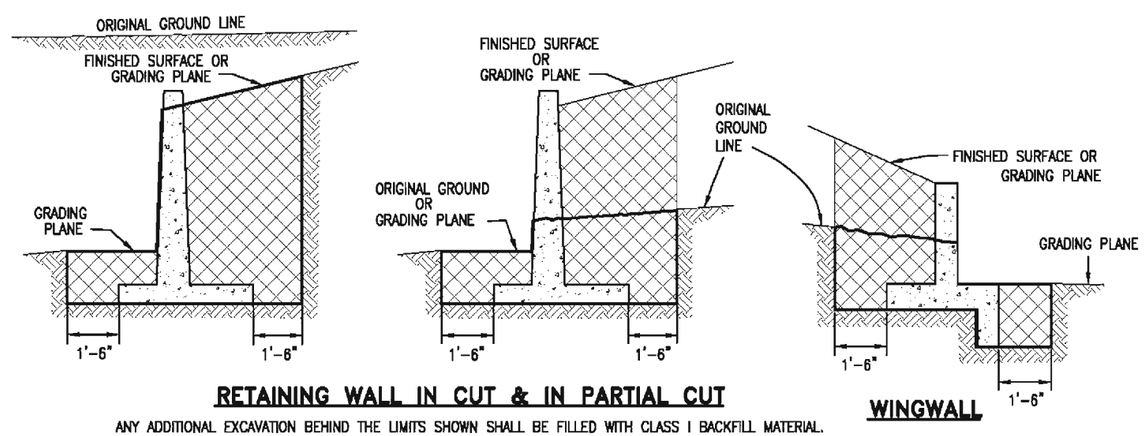


STRUCTURE EXCAVATION MEASUREMENT FOR CONCRETE BOX CULVERTS





STRUCTURE EXCAVATION MEASUREMENT FOR DIVISION BOXES



RETAINING WALL IN CUT & IN PARTIAL CUT

ANY ADDITIONAL EXCAVATION BEHIND THE LIMITS SHOWN SHALL BE FILLED WITH CLASS I BACKFILL MATERIAL. THE ADDITIONAL EXCAVATION AND BACKFILL WILL NOT BE MEASURED AND PAID FOR.

LEGEND

- STRUCTURE EXCAVATION LIMITS
- STRUCTURE BACKFILL, CLASS 1 OR 2, AS SHOWN ON PLANS
- CONCRETE

Computer File Information		
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Last Modification Date: 07/04/06	Initials: LTA	
Full Path: www.dot.state.co.us/DesignSupport/		
Drawing File Name: 206010202.dwg		
CAD Ver.: MicroStation V8	Scale: Not to Scale	Units: English

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(R-X)	
(R-X)	
(R-X)	

Colorado Department of Transportation
4201 East Arkansas Avenue
Denver, Colorado 80222
Phone: (303) 757-9083
Fax: (303) 757-9820
Project Development Branch SRJ/LTA

EXCAVATION AND BACKFILL FOR STRUCTURES

Issued By: Project Development Branch on July 04, 2006

STANDARD PLAN NO.
M-206-1
Sheet No. 2 of 2

J3 Engineering Consultants Inc.
3151 S. Vaughn Way, Suite 680
Aurora, CO 80014
Tel: 303-368-5601 Fax: 303-368-5603

DESIGNED BY:	JRD	DATE: 11/14/08
DRAWN BY:	JAN	DATE: 02/28/09
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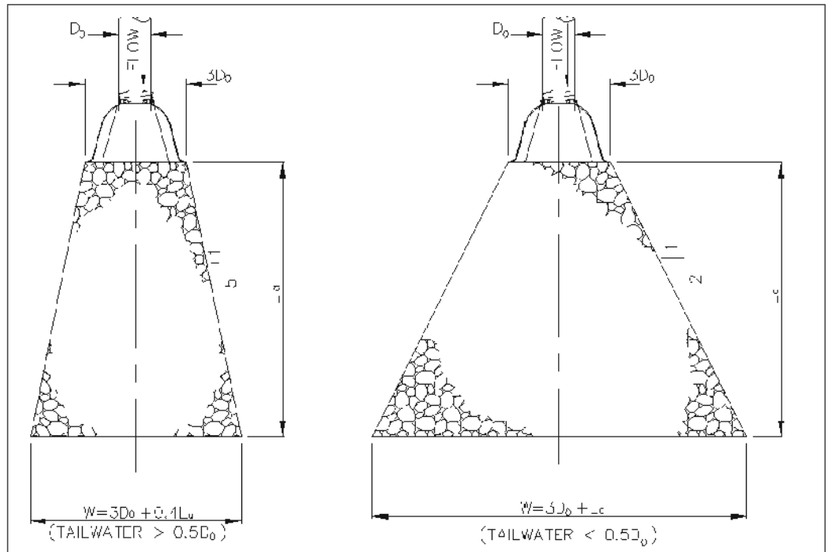
CITY OF STEAMBOAT SPRINGS

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS

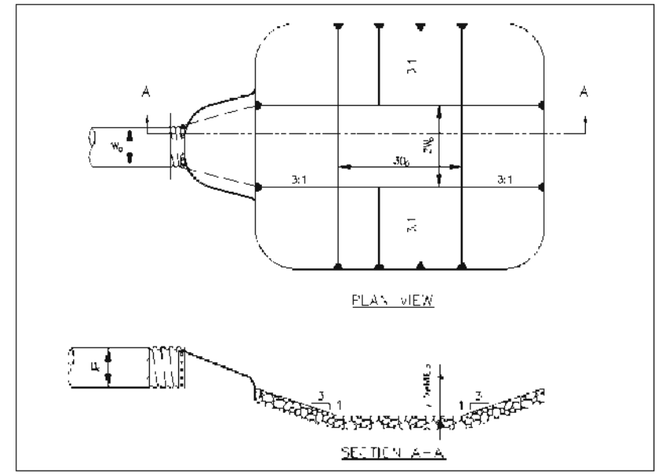
TYPICAL DETAILS

FIGURE A3



Reference: US EPA (modified to show flared end section)

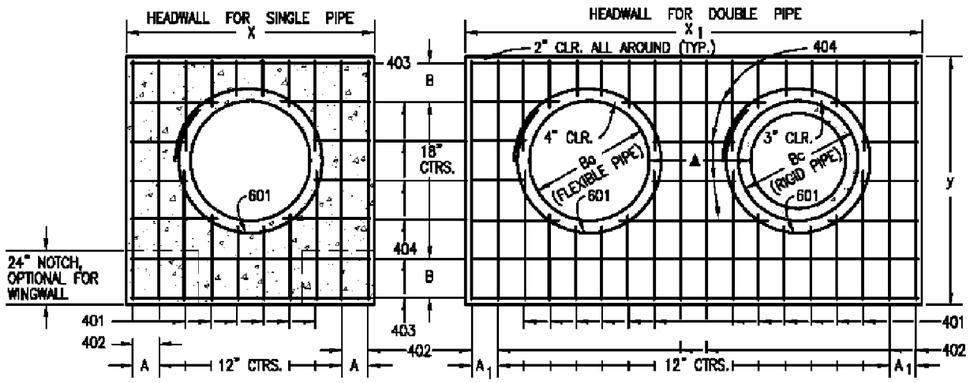
CULVERT OUTLET PROTECTION CONFIGURATION (FIGURE 5.10.16)



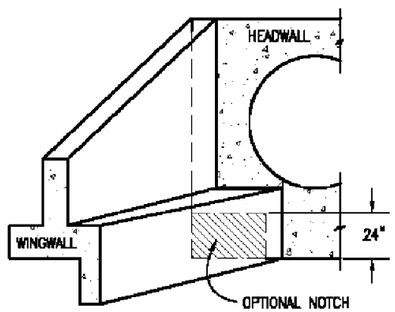
PREFORMED SCOUR HOLE (FIGURE 5.10.17)

P:\Jobs\Steamboat Springs\Old Town Masterplan\MasterPlan\Figures\A1-DETAILS.dwg, Layout (3), 4/16/2009 2:44:37 PM, jduncan

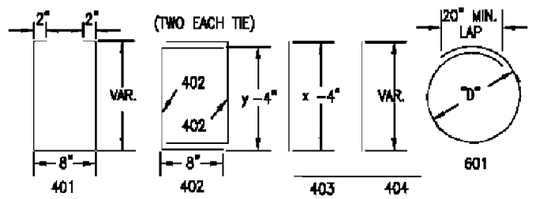
J3 Engineering Consultants Inc. 3151 S. Vaughn Way, Suite 680 Aurora, CO 80014 Tel: 303-368-5601 Fax: 303-368-5603	DESIGNED BY: JRD DATE: 11/14/08 DRAWN BY: JAN DATE: 02/28/09 CHECKED BY: KSC DATE: 04/17/09	CITY OF STEAMBOAT SPRINGS	OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS	TYPICAL DETAILS	FIGURE A4



TYPICAL BAR LAYOUT FOR CONCRETE HEADWALLS

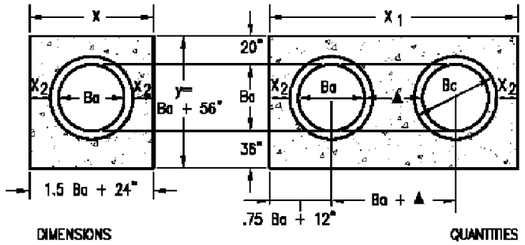


FRONT VIEW



"D" = RIGID PIPE = Bc + 6"
FLEXIBLE PIPE = Ba + 8"
FLEXIBLE ARCH = SPAN + 8"
STRUCTURAL PLATE ARCH = RISE + 8"

BAR BENDING



DIMENSIONS									QUANTITIES			
									CONCRETE		STEEL ■	
Ba IN.	Bc IN.	X FT.-IN.	A IN.	X1 FT.-IN.	A1 IN.	y FT.-IN.	B IN.	X2 IN.	SGL CU.YD.	DBL CU.YD.	SGL LBS.	DBL LBS.
54	65	8-9	8½	15-8	7	9-2	17	20	2.12	3.55	209	364
60	72	9-6	7	17-0	10	9-8	11	21	2.35	3.99	236	414
66	79	10-3	11½	18-6	7	10-2	14	22	2.60	4.44	249	453
72	86	11-0	10	20-0	10	10-8	17	23	2.85	4.91	270	476
78	93	11-9	8½	21-3	11	11-2	11	24	3.11	5.29	306	527
84	100	12-6	7	22-6	7	11-8	14	25	3.38	5.68	333	572
90	107	13-3	11½	23-9	8½	12-2	17	26	3.66	6.08	335	593
96	114	14-0	10	25-0	10	12-8	11	27	3.94	6.48	379	649
102	121	14-9	8½	26-3	11½	13-2	14	28	4.24	6.89	400	664
108	128	15-6	7	27-6	7	13-8	17	29	4.54	7.30	424	707

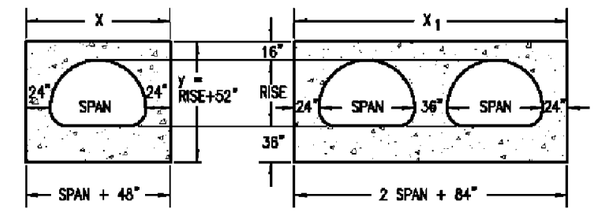
HEADWALL FOR RIGID ROUND PIPE

GENERAL NOTES

1. CONCRETE SHALL BE CLASS B.
2. HEADWALL SHALL BE PERPENDICULAR TO THE PIPE ℄ UNLESS OTHERWISE SHOWN ON THE PLANS. TABULATED DIMENSIONS AND QUANTITIES MUST BE ADJUSTED FOR SKEWED INSTALLATIONS.
3. FOR WINGWALL DETAILS, SEE STANDARD PLAN M-601-20.
4. VOLUME OCCUPIED BY PIPE HAS BEEN DEDUCTED FROM STEEL AND CONCRETE QUANTITIES.
5. EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED ¾ IN.
6. ALL REINFORCING BARS SHALL HAVE A 2 IN. MINIMUM CLEARANCE.

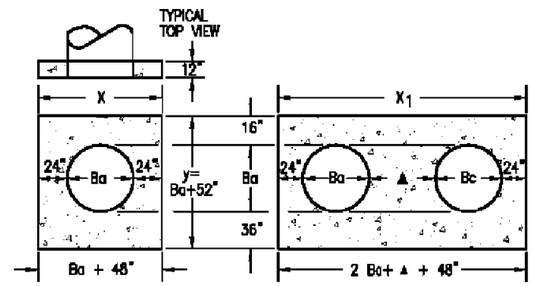
▲ WHEN TWO OR MORE PIPES ARE LAID SIDE BY SIDE, THEY SHALL BE PLACED SO THAT THE ADJACENT PIPES WILL BE ½ INSIDE DIAMETER APART, OR ½ INSIDE SPAN APART, OR 3 FT. APART (INCLUDING WALL THICKNESS), WHICHEVER IS LESS.

■ ADD 0.89 x (X OR X1) (LB.) WHEN APRON IS REQUIRED.



DIMENSIONS									QUANTITIES			
									CONCRETE		STEEL ■	
EQUIV. Ba IN.	SPAN IN.	RISE IN.	X FT.-IN.	A IN.	X1 FT.-IN.	A1 IN.	y FT.-IN.	B IN.	SGL CU. YD.	DBL CU. YD.	SGL LBS.	DBL LBS.
72	81	59	10-9	8½	20-6	7	9-3	17½	2.72	5.10	250	467
78	87	63	11-3	11½	21-6	7	9-7	10½	2.85	5.34	275	531
84	95	67	11-9	8½	22-10	9	9-11	12½	3.08	5.79	290	547
90	103	71	12-7	7½	24-2	11	10-3	15	3.30	6.21	321	591
96	112	75	13-4	12	25-8	8	10-7	16½	3.52	6.65	314	606
102	117	79	13-9	8½	26-6	7	10-11	9½	3.63	6.86	358	672
108	128	83	14-8	8	28-4	12	11-3	11½	3.96	7.51	376	699

HEADWALL FOR FLEXIBLE PIPE ARCH

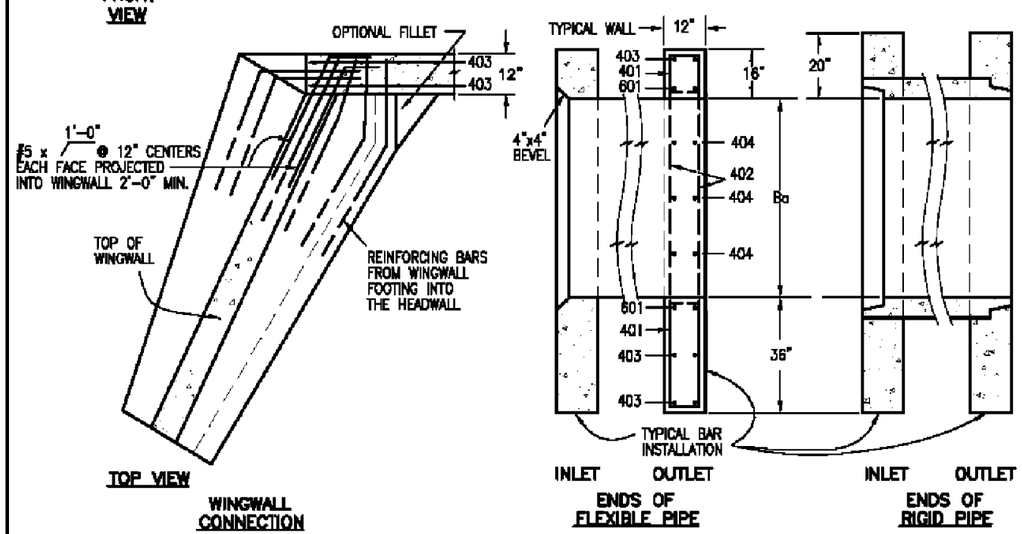


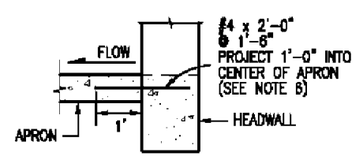
DIMENSIONS								QUANTITIES			
								CONCRETE		STEEL ■	
Ba IN.	X FT.-IN.	A IN.	X1 FT.-IN.	A1 IN.	y FT.-IN.	B IN.		SGL CU. YD.	DBL CU. YD.	SGL LBS.	DBL LBS.
54	8-6	7	15-3	11½	8-10	15		2.19	3.81	211	358
60	9-0	10	16-6	7	9-4	18		2.36	4.25	217	396
66	9-6	7	17-9	8½	9-10	12		2.58	4.70	252	454
72	10-0	10	19-0	10	10-4	15		2.76	5.17	255	472
78	10-6	7	20-0	10	10-10	18		2.96	5.56	276	499
84	11-0	10	21-0	10	11-4	12		3.19	5.95	297	553
90	11-6	7	22-0	10	11-10	15		3.40	6.36	317	517
96	12-0	10	23-0	10	12-4	18		3.62	6.79	321	597
102	12-6	7	24-0	10	12-10	12		3.84	7.21	364	663
108	13-0	10	25-0	10	13-4	15		4.06	7.63	362	678

HEADWALL FOR FLEXIBLE ROUND PIPE

DIMENSIONS								QUANTITIES			
								CONCRETE		STEEL ■	
EQUIV. Ba IN.	SPAN FT.-IN.	RISE FT.-IN.	X FT.-IN.	A IN.	X1 FT.-IN.	A1 IN.	y FT.-IN.	B IN.	SGL CU. YD.	DBL CU. YD.	SGL LBS.	DBL LBS.
66	6-1	4-7	10-1	10½	19-2	11	8-11	15½	2.52	4.70	232	424
75	7-0	5-1	11-0	10	21-0	10	9-5	9½	2.80	5.25	282	509
84	7-11	5-7	11-11	9½	22-10	9	9-11	12½	3.08	5.79	291	540
93	8-10	6-1	12-10	9	24-8	8	10-5	15½	3.36	6.33	309	622
102	9-9	6-7	13-9	8½	26-6	7	10-11	9½	3.63	6.86	379	673
111	10-11	7-1	14-11	9½	28-10	9	11-5	12½	4.05	7.67	377	711
120	11-10	7-7	15-10	9	30-8	8	11-11	15½	4.36	8.28	395	731
132	12-10	8-4	16-10	9	32-8	8	12-8	11	4.75	9.03	441	839
141	14-1	8-9	18-1	10½	35-2	11	13-1	13½	5.17	9.86	448	931
150	15-4	9-3	19-4	12	37-8	8	13-7	16½	5.69	10.88	490	953
159	15-10	9-10	19-10	9	38-8	8	14-2	11	5.89	11.25	534	1019

HEADWALL FOR STRUCTURAL PLATE ARCH





WHEN APRON IS REQUIRED

SKEW ANGLE A°	90	85	80	75	70	65	60	55	50	45	40	35	30
FACTOR (cosecA°)	1.000	1.004	1.015	1.035	1.064	1.103	1.155	1.221	1.305	1.414	1.556	1.743	2.000

SKEW FACTOR TABLE

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CAD Ver.: MicroStation V8 Scale: Not to Scale	Units: English

(R-X) (R-X) (R-X) (R-X)

Sheet Revisions	
Date:	Comments

Colorado Department of Transportation
4201 East Arkansas Avenue
Denver, Colorado 80222
Phone: (303) 757-9083
Fax: (303) 757-9820
Project Development Branch SRJ/LTA

HEADWALLS FOR PIPES

Issued By: Project Development Branch on July 04, 2006

STANDARD PLAN NO.
M-601-10
Sheet No. 1 of 1

J3 Engineering Consultants Inc.
3151 S. Vaughn Way, Suite 680
Aurora, CO 80014
Tel: 303-368-5601 Fax: 303-368-5603

DESIGNED BY:	JRD	DATE:	11/14/08
DRAWN BY:	JAN	DATE:	02/28/09
CHECKED BY:	KSC	DATE:	04/17/09

CITY OF STEAMBOAT SPRINGS

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS

TYPICAL DETAILS

FIGURE A5

27 PM, jduncan

Figure 5.7.2 Collector and Arterial Inundation Limits

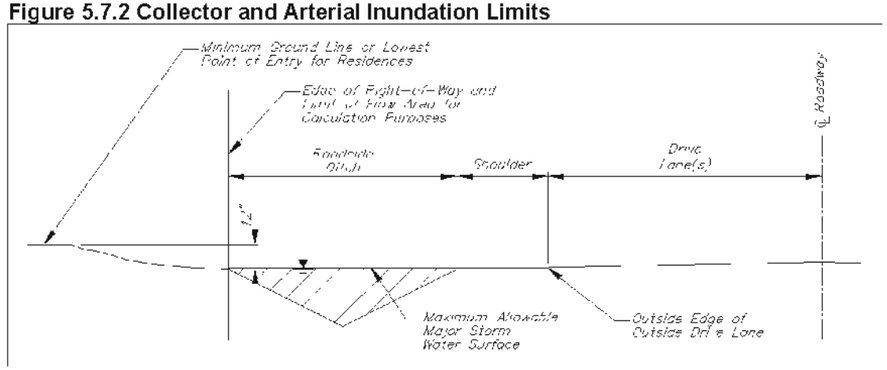
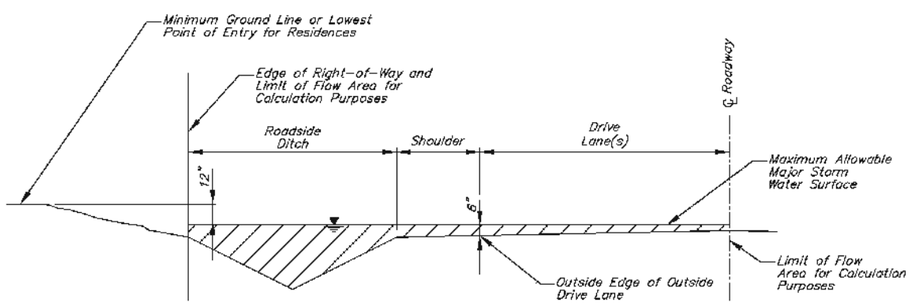
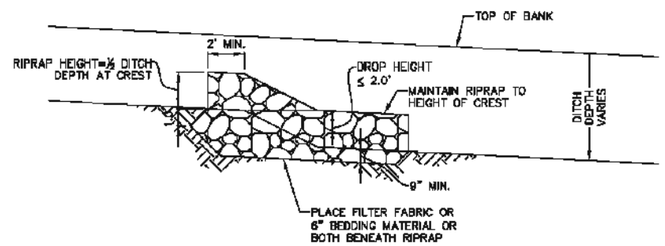


Figure 5.7.3 Local Roadway Inundation Limits



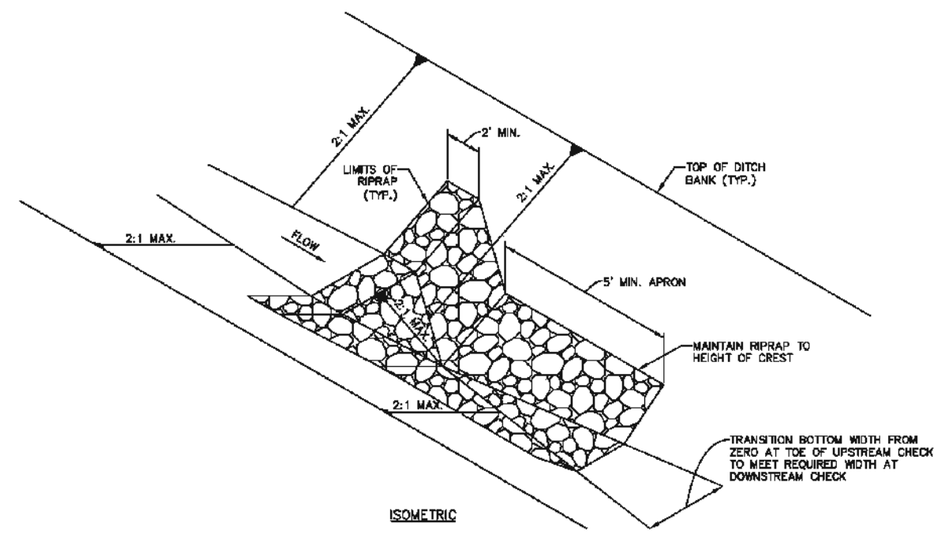
COLLECTOR, ARTERIAL AND LOCAL ROADWAY INUNDATION LIMITS



PROFILE

NOTES:

1. RIPRAP SHALL BE CRUSHED, ANGULAR, WASHED ROCK HAVING THE SMALLEST DIMENSION AT LEAST 3" AND A LARGEST DIMENSION NO MORE THAN 12" UNLESS OTHERWISE SPECIFIED AND APPROVED. INCREASE ROCK SIZE BY 25% IF ROUNDED ROCK MUST BE USED.
2. RIPRAP SHALL HAVE A MINIMUM SPECIFIC GRAVITY OF 2.5.
3. FILTER FABRIC AND BEDDING SHALL MEET THE REQUIREMENTS OF THE CITY'S STANDARD SPECIFICATIONS.
4. INSTALLATION SHALL BE PER THE CITY'S STANDARD SPECIFICATIONS.

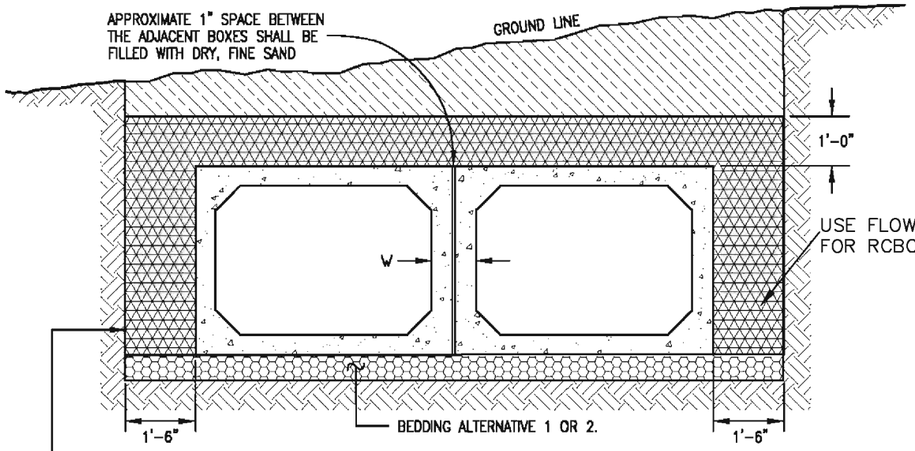


ISOMETRIC

DITCH CHECK SCHEMATIC DETAILS (FIGURE 5.7.4)

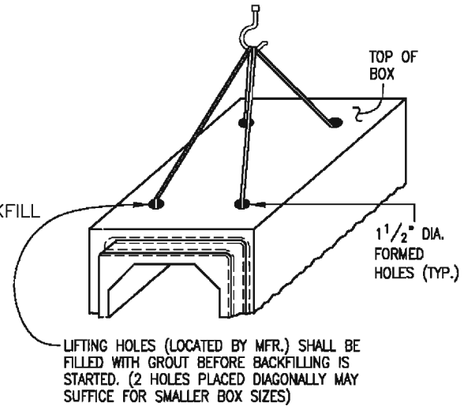
P:\Jobs\Steamboat Springs\C

J3 Engineering Consultants Inc. 3151 S. Vaughn Way, Suite 680 Aurora, CO 80014 Tel: 303-368-5601 Fax: 303-368-5603	DESIGNED BY: JRD DRAWN BY: JAN CHECKED BY: KSC	DATE: 11/14/08 DATE: 02/28/09 DATE: 04/17/09	CITY OF STEAMBOAT SPRINGS	OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS	TYPICAL DETAILS	FIGURE A6

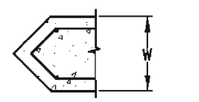


EXCAVATION & BACKFILL

(PARALLEL PRECAST BOX CULVERT INSTALLATION)

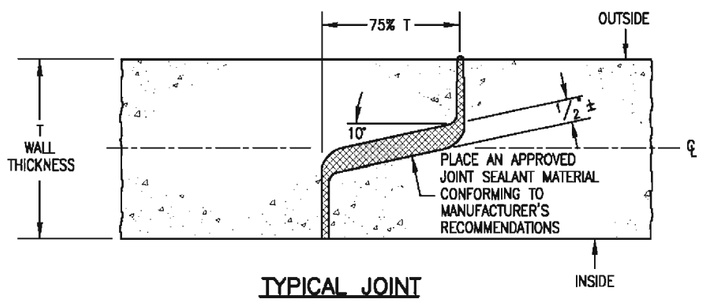


LIFTING

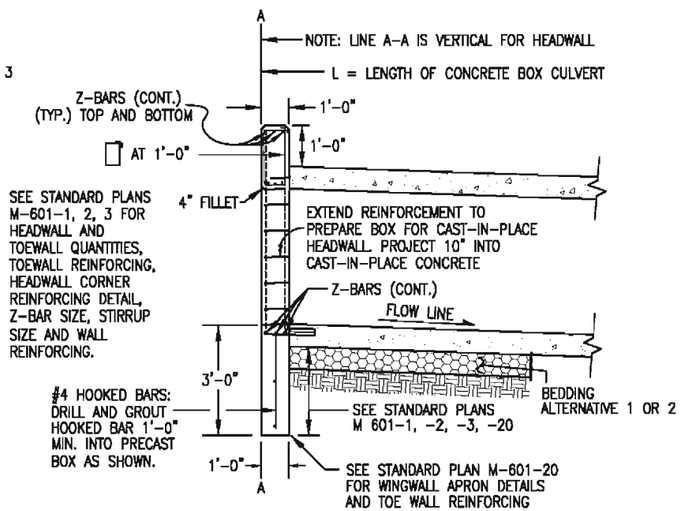


NOSE ANGLE DETAIL

SEE STANDARD PLANS M-601-2, AND 3 TYPICAL AT ADJACENT BOXES DRILL AND GROUT REINFORCING BARS (TYP.)



TYPICAL JOINT



CULVERT END

(WITH HEADWALL)

GENERAL NOTES

1. PRECAST CONCRETE BOX CULVERT SHALL CONFORM TO THE REQUIREMENTS OF THE FOLLOWING SPECIFICATIONS:

ITEM OR CONDITION	MIN. COVER	AASHTO	EQUIV. ASTM
2 FT. OR MORE COVER	2 FT.	M 259, TABLE 2	C 1433, TABLE 2
LESS THAN 2 FT. COVER	0 FT.	M 273, TABLE 2	C 1433, TABLE 2
PREFORMED JOINT MATERIAL	———	M 198, 6.1 OR 6.2	C 990, 6.1 OR 6.2

THE SPECIFICATIONS LISTED ABOVE SHOW REINFORCING PLACEMENT, EARTH COVER AND OTHER DETAILS NEEDED TO MANUFACTURE THE BOX CULVERTS.

2. THE CONTRACTOR SHALL SUBMIT TWO SETS OF WORKING DRAWINGS TO THE ENGINEER FOR INFORMATION ONLY, PRIOR TO FABRICATION.

3. BEDDING ALTERNATIVE 1 OR 2 IS REQUIRED:

   BEDDING ALTERNATIVE IS AT THE CONTRACTOR'S OPTION. BEDDING AND EXCAVATION FOR BEDDING WILL NOT BE MEASURED AND PAID FOR SEPARATELY, BUT SHALL BE INCLUDED IN THE WORK.

   BEDDING ALTERNATIVE 1 CONSISTS OF 6 IN. OF AGGREGATE BASE COURSE (CLASS 6) COMPACTED TO NOT LESS THAN 95% MAXIMUM DENSITY DETERMINED IN CONFORMANCE WITH AASHTO T 180.

   BEDDING ALTERNATIVE 2 CONSISTS OF AN 3 IN. THICK, MINIMUM, LEAN CONCRETE BASE. CEMENT CONTENT = 250 LBS./CU. YD.

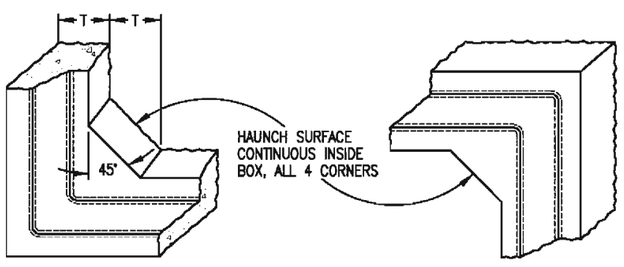
   AGGREGATE GRADATION FOR ALTERNATIVE 2 BEDDING:

   PASSING 2 IN. SIEVE — 100%
   PASSING NO. 4 SIEVE — 20% TO 70%
   PASSING NO. 200 SIEVE — 5% TO 15%

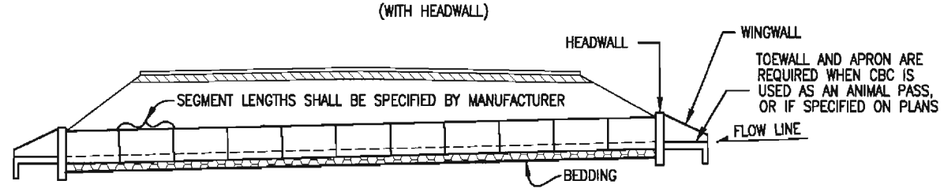
4. CLASS A DRAINAGE GEOTEXTILE SHALL BE COMPLETELY WRAPPED AROUND ALL CBC JOINTS. THE GEOTEXTILE SHALL EXTEND A MINIMUM OF 1 FT. ON EACH SIDE OF JOINTS AND SHALL OVERLAP AND BE SECURELY ATTACHED FOR AT LEAST 1 FT. AT ITS ENDS. THE WRAP SHALL BE A SMOOTH FIT (NOT LOOSE OR STRETCHED) JUST PRIOR TO BACKFILL. THE GEOTEXTILE MATERIAL SHALL MEET THE APPLICABLE REQUIREMENTS OF SECTION 420. COST FOR GEOTEXTILE WILL NOT BE MEASUREO AND PAID FOR SEPARATELY, BUT SHALL BE INCLUDED IN THE WORK.

LEGEND

- STRUCTURE EXCAVATION LIMITS
- STRUCTURE BACKFILL, (CLASS 1)
- EMBANKMENT MATERIAL
- EARTH
- BEDDING
- CONCRETE



CORNERS



TYPICAL CULVERT INSTALLATION

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CAD Ver.: MicroStation V8 Scale: Not to Scale Units: English			

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Colorado Department of Transportation
4201 East Arkansas Avenue
Denver, Colorado 80222
Phone: (303) 757-9083
Fax: (303) 757-9820
Project Development Branch SRJ/LTA

PRECAST CONCRETE BOX CULVERT

Issued By: Project Development Branch on July 04, 2006

STANDARD PLAN NO.
M-603-3
Sheet No. 1 of 1

J3 Engineering Consultants Inc.
3151 S. Vaughn Way, Suite 680
Aurora, CO 80014
Tel: 303-368-5601 Fax: 303-368-5603

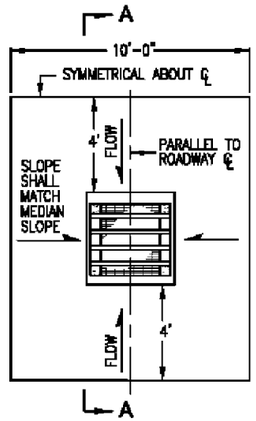
DESIGNED BY: JRD DATE: 11/14/08
DRAWN BY: JAN DATE: 02/28/09
CHECKED BY: KSC DATE: 04/17/09

CITY OF STEAMBOAT SPRINGS

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS

TYPICAL DETAILS

FIGURE A7

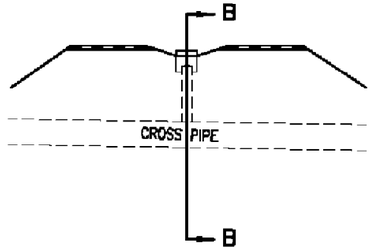


INLET WITH DITCH PAVING

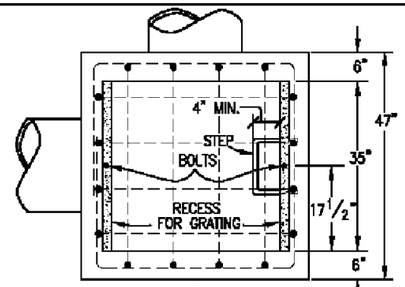
STEEL GRATE QUANTITIES

NO. PIECES	DESCRIPTION	LENGTH	LBS PER FT.	WEIGHT (LBS.)
4	S4 x 7.7 BEAM	40"	7.70	103
2	3 1/2" x 1/4" FLAT	26 5/8"	2.98	13
2	3" x 1/4" FLAT	26 5/8"	2.55	12

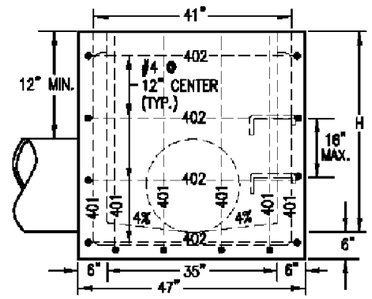
TOTAL LBS. – 128



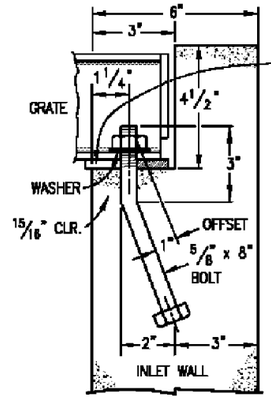
SECTION VIEW



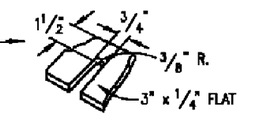
PLAN



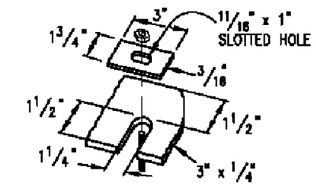
ELEVATION
CONCRETE INLET



GRATE INSTALLATION DETAIL



SLOT DETAIL



ALTERNATE SLOT AND HOLD DOWN PLATE DETAIL

QUANTITIES FOR ONE INLET

H	CONCRETE (CU. YDS.) ▼	STEEL (LBS.) ▼	NO. STEPS REQ'D.
2'-6"	0.9	75	0
3'-0"	1.0	80	0
3'-6"	1.2	96	0
4'-0"	1.3	101	1
4'-6"	1.4	116	2
5'-0"	1.5	122	2
5'-6"	1.7	137	2
6'-0"	1.8	142	3
6'-6"	1.9	158	3
7'-0"	2.0	163	3
7'-6"	2.2	179	4
8'-0"	2.3	184	4
8'-6"	2.4	199	4
9'-0"	2.5	205	5
9'-6"	2.7	220	5
10'-0"	3.0	235	6
11'-6"	3.4	251	6

▼ PIPE INSIDE DIAMETER SHALL BE 30 IN. OR LESS. CONCRETE AND STEEL QUANTITIES ARE FOR ONE ENTIRE INLET BEFORE DEDUCTION FOR VOLUME OCCUPIED BY PIPE. WEIGHT OF STEEL INCLUDES A RING FOR THE MAXIMUM PIPE DIAMETER.

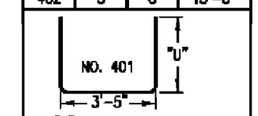
GENERAL NOTES

1. CONCRETE SHALL BE CLASS B. INLET MAY BE CAST-IN-PLACE OR PRECAST.
2. REINFORCING BARS SHALL BE EPOXY COATED AND DEFORMED #4, AND SHALL HAVE A MINIMUM 2 IN. CLEARANCE. CUT OR BEND AROUND PIPES AS REQUIRED.
3. CONCRETE SLOPE AND DITCH PAVING SHALL BE IN ACCORDANCE WITH SECTION 507. REINFORCEMENT FOR CONCRETE SLOPE PAVING SHALL BE 6 X 6 – W1.4 X W1.4 OR 6 X 6 – W2.1 X W2.1.
4. STRUCTURAL STEEL FOR GRATES AND GRATE INSTALLATION HARDWARE SHALL BE GALVANIZED, AND SHALL BE IN ACCORDANCE WITH SUBSECTION 712.06.
5. THE STANDARD INLET GRATES SHALL BE USED ON ALL TYPE C INLETS UNLESS CLOSE MESH GRATES ARE SPECIFIED ON THE PLANS.
6. STEPS SHALL BE PROVIDED WHEN INLET DIMENSION "H" IS EQUAL TO OR GREATER THAN 3 FT. – 6 IN., AND SHALL CONFORM TO AASHTO M 199.
7. SEE STANDARD PLAN M-604-11, FOR REINFORCEMENT AROUND THE PIPE OPENING.

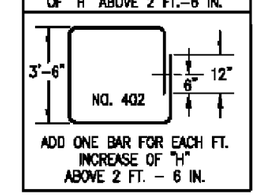
* CONCRETE SLOPE AND DITCH PAVING WILL BE REQUIRED WHEN SHOWN ON THE PLANS.

BAR LIST FOR H=2 FT-6 IN. AND BENDING DIAGRAM

MARK	NO. REQ'D.	HEIGHT	LENGTH
401	2	2'-3"	7'-11"
401	6	2'-7"	8'-7"
402	3	"U"	15'-0"

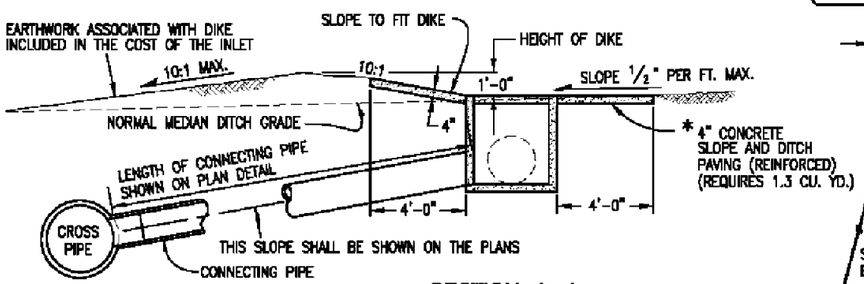


"U" INCREASE DIMENSION 6 IN. FOR EACH 6 IN. INCREASE OF "H" ABOVE 2 FT.–6 IN.



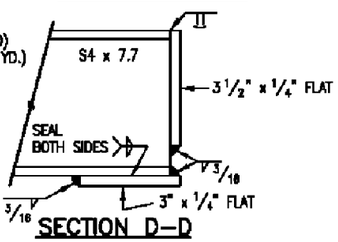
ADD ONE BAR FOR EACH FT. INCREASE OF "H" ABOVE 2 FT. – 6 IN.

402 BARS SHALL BE EQUALLY SPACED FROM EACH OTHER.

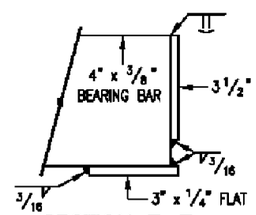


SECTION B-B
INLET CONNECTED TO A CROSS PIPE

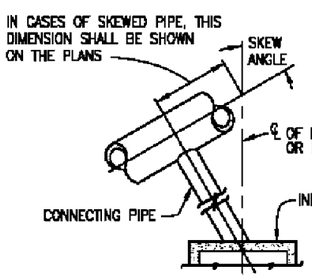
SECTION A-A
INLET ON GRADE
(FLOW FROM ONE DIRECTION)



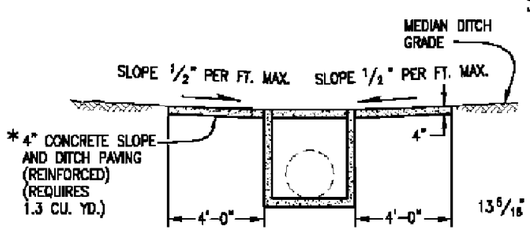
SECTION D-D



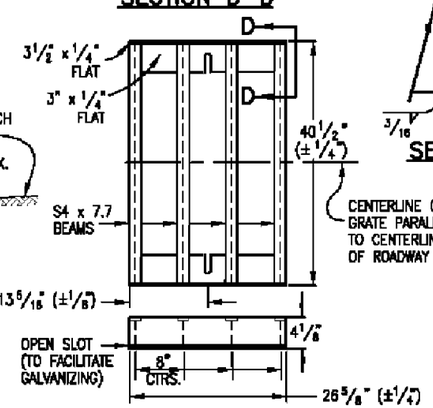
SECTION E-E



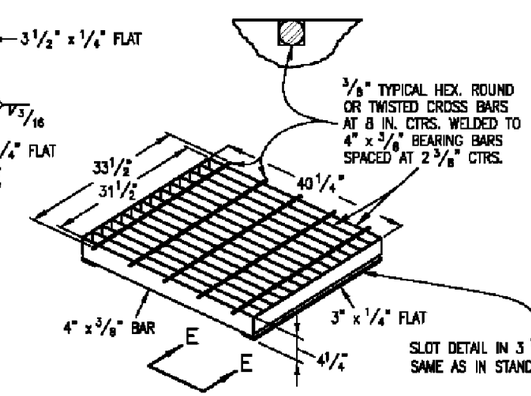
INLET CONNECTED TO A
SKEWED CROSS PIPE



SECTION A-A
INLET AT BOTTOM
OF VERTICAL CURVE
(FLOW FROM TWO DIRECTIONS)



STANDARD INLET GRATE



CLOSE MESH GRATE
USE FOR PEDESTRIAN AND BICYCLE AREAS ONLY.

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Last Modification Date: 07/04/06	Initials: LTA	
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Sheet Revisions	
Date:	Comments

Colorado Department of Transportation
4201 East Arkansas Avenue
Denver, Colorado 80222
Phone: (303) 757-9083
Fax: (303) 757-9820
Project Development Branch SRJ/LTA

INLET, TYPE C

Issued By: Project Development Branch on July 04, 2006

STANDARD PLAN NO.
M-604-10
Sheet No. 1 of 1

J3 Engineering Consultants Inc.
3151 S. Vaughn Way, Suite 680
Aurora, CO 80014
Tel: 303-368-5601 Fax: 303-368-5603

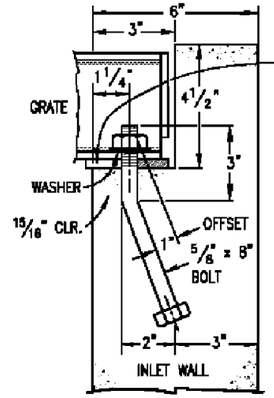
DESIGNED BY:	JRD	DATE:	11/14/08
DRAWN BY:	JAN	DATE:	02/28/09
CHECKED BY:	KSC	DATE:	04/17/09

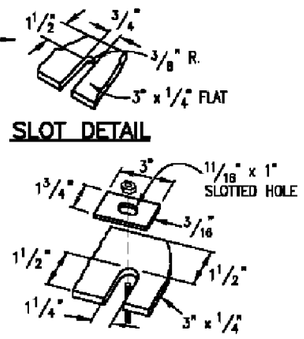
CITY OF STEAMBOAT SPRINGS

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS

TYPICAL DETAILS

FIGURE A8

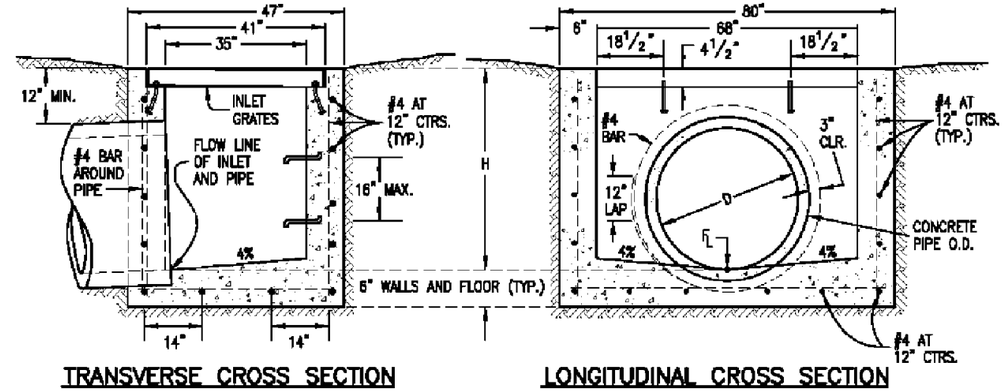




SLOT DETAIL

ALTERNATE SLOT AND HOLD DOWN PLATE DETAIL

GRATE INSTALLATION DETAIL



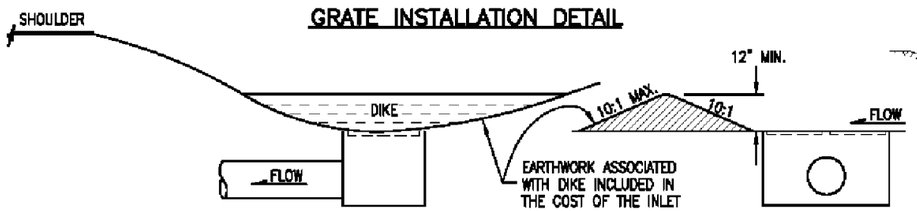
TRANSVERSE CROSS SECTION

LONGITUDINAL CROSS SECTION

LEVEL GRATE INSTALLATION

GENERAL NOTES

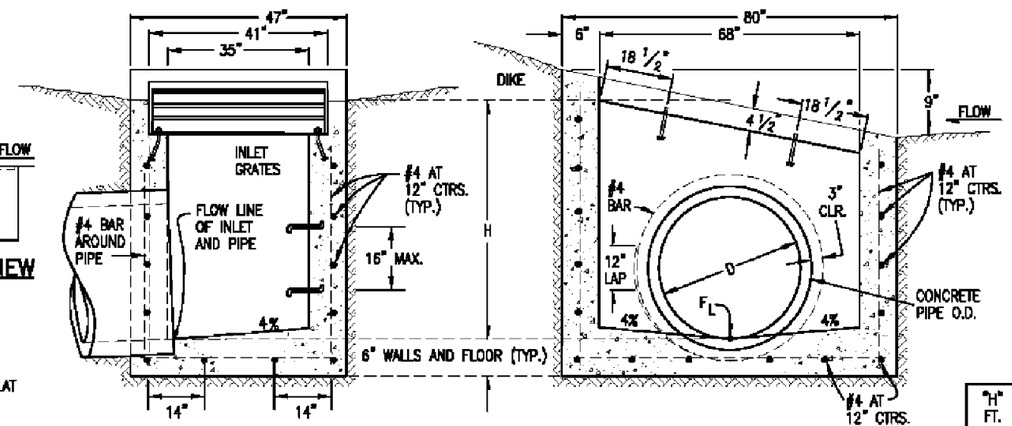
1. CONCRETE SHALL BE CLASS B. INLET MAY BE CAST-IN-PLACE OR PRECAST.
2. SEE PLANS FOR SIZE AND LOCATION OF PIPE.
3. STRUCTURAL STEEL FOR GRATES AND GRATE INSTALLATION HARDWARE SHALL BE GALVANIZED AND SHALL BE IN ACCORDANCE WITH SUBSECTION 712.06.
4. STANDARD INLET GRATES SHALL BE USED ON ALL TYPE D INLETS UNLESS CLOSE MESH GRATES ARE SPECIFIED ON THE PLANS.
5. STEPS SHALL BE PROVIDED WHEN INLET DIMENSION "H" IS EQUAL TO OR GREATER THAN 3 FT.-6 IN. AND SHALL CONFORM WITH AASHTO M 199.
6. REINFORCING BARS SHALL BE EPOXY COATED AND DEFORMED #4, AND SHALL HAVE A 2 IN. MINIMUM CLEARANCE. CUT OR BEND BARS AROUND PIPE AS REQUIRED.



TRANSVERSE VIEW

DIKE

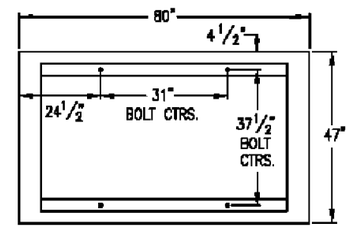
LONGITUDINAL VIEW



TRANSVERSE CROSS SECTION

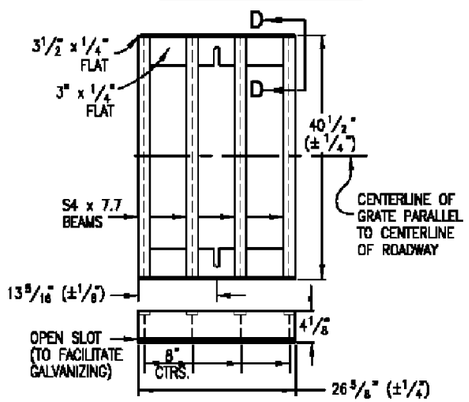
LONGITUDINAL CROSS SECTION

SLOPING GRATE INSTALLATION

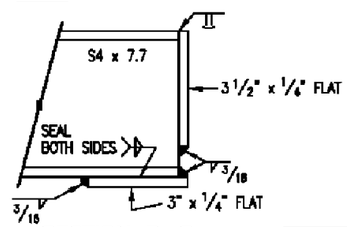


PLAN VIEW

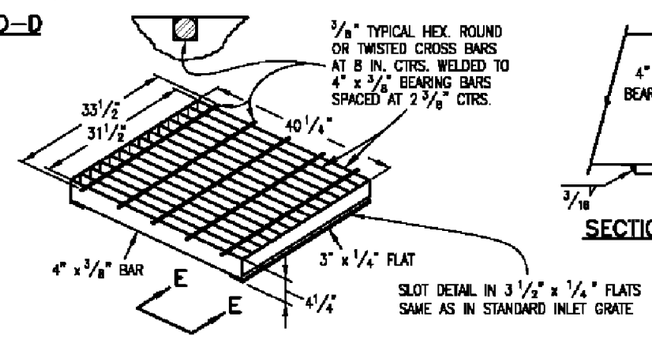
(SHOWING ANCHOR BOLT LAYOUT)



STANDARD INLET GRATE

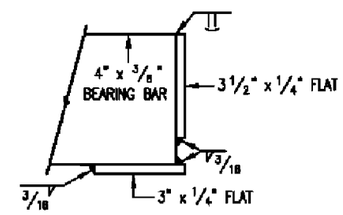


SECTION D-D



CLOSE MESH GRATE

USE FOR PEDESTRIAN AND BICYCLE AREAS ONLY.



SECTION E-E

OUTLET PIPE INSIDE DIA. FT. - "D"	MIN. "H" FT.
1.5	3.0
2.0	3.5
2.5	4.0
3.0	4.5
3.5	5.0

TWO STEEL GRATE PER INLET QUANTITIES

NO. PIECES	DESCRIPTION	LENGTH	LBS PER FT.	WEIGHT (LBS.)
8	S4 x 7.7 BEAM	40"	7.70	206
4	3 1/2" x 1/4" FLAT	26 5/8"	2.98	26
4	3" x 1/4" FLAT	26 5/8"	2.55	24

TOTAL LBS. - 256

"H" FT.	CONCRETE CU. YDS. ▼	STEEL LBS. ▼	CIRCULAR PIPE RANGE INSIDE DIA., IN. - "D"
3.0	1.5	127	18
3.5	1.7	149	18-24
4.0	1.9	157	18-30
4.5	2.0	179	18-36
5.0	2.2	187	18-42
5.5	2.4	208	18-42
6.0	2.6	215	18-42
6.5	2.8	236	18-42
7.0	2.9	243	18-42
7.5	3.1	264	18-42
8.0	3.3	271	18-42
8.5	3.5	292	18-42
9.0	3.6	299	18-42
9.5	3.8	320	18-42
10.0	4.0	327	18-42

▼ CONCRETE AND STEEL QUANTITIES ARE FOR ONE ENTIRE INLET BEFORE DEDUCTION FOR VOLUME OCCUPIED BY PIPE. WEIGHT OF STEEL INCLUDES A RING FOR THE MAXIMUM PIPE DIAMETER.

QUANTITIES FOR ONE INLET

Computer File Information		Sheet Revisions	
Creation Date: 07/04/06	Initials: SJR	Date:	Comments
Last Modification Date: 07/04/06	Initials: LTA		
Full Path: www.dot.state.co.us/DesignSupport/			
Drawing File Name: 6040110101.dwg			
CAD Ver.: MicroStation V8 Scale: Not to Scale Units: English			

R-X R-X R-X R-X

Colorado Department of Transportation
4201 East Arkansas Avenue
Denver, Colorado 80222
Phone: (303) 757-9083
Fax: (303) 757-9820
Project Development Branch SRJ/LTA

INLET, TYPE D

Issued By: Project Development Branch on July 04, 2006

STANDARD PLAN NO.

M-604-11

Sheet No. 1 of 1

J3 Engineering Consultants Inc.
3151 S. Vaughn Way, Suite 680
Aurora, CO 80014
Tel: 303-368-5601 Fax: 303-368-5603

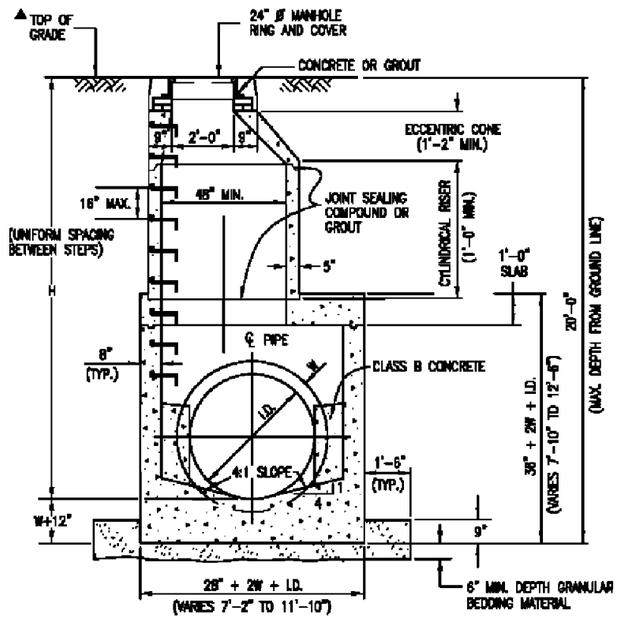
DESIGNED BY: JRD DATE: 11/14/08
DRAWN BY: JAN DATE: 02/28/09
CHECKED BY: KSC DATE: 04/17/09

CITY OF STEAMBOAT SPRINGS

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS

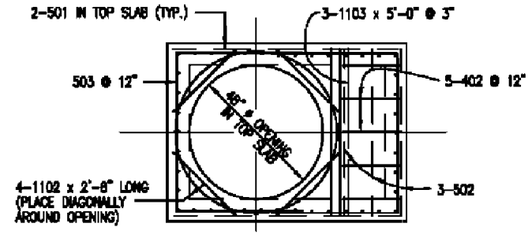
TYPICAL DETAILS

FIGURE A9

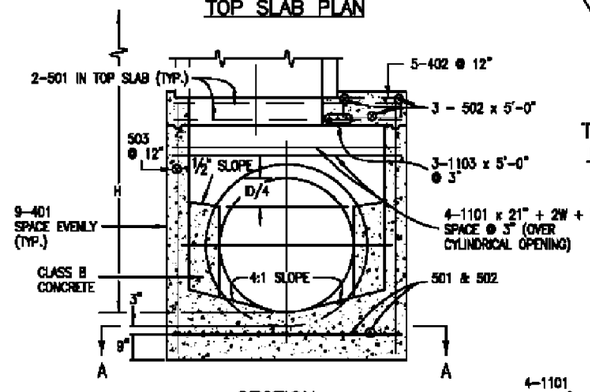


SECTION

MANHOLE BOX BASE



TOP SLAB PLAN



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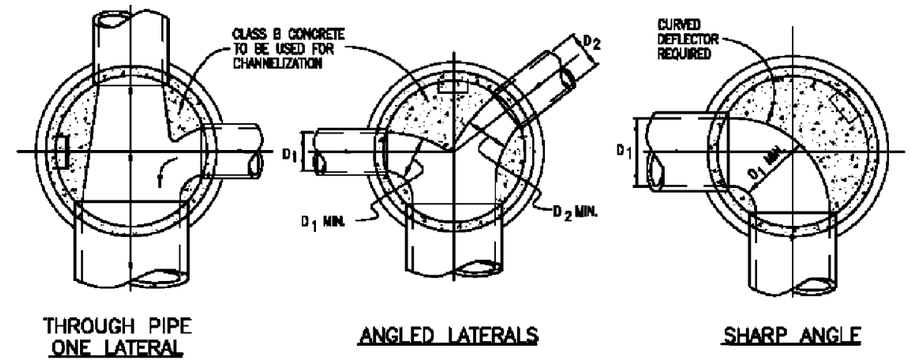
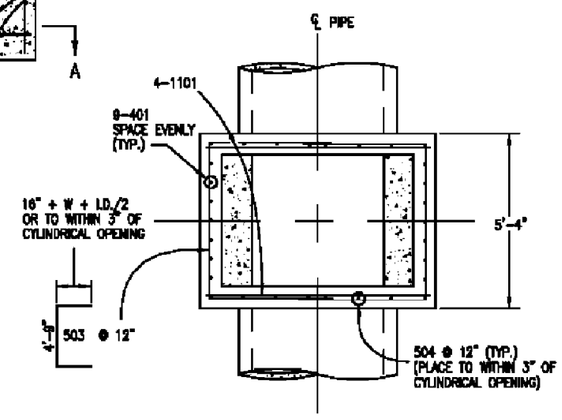
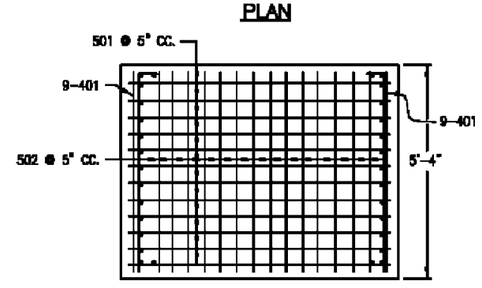


TYPICAL CHANNELIZATION DETAILS



PLAN



SECTION A-A

(STEEL IN BOTTOM OF BASE)

GENERAL NOTES

1. SINCE ALL PIPE ENTRIES INTO THE BASE ARE VARIABLE, THE DIMENSIONS SHOWN ARE TYPICAL. ACTUAL DIMENSIONS AND QUANTITIES FOR CONCRETE AND REINFORCEMENT SHALL BE AS REQUIRED IN THE WORK.
2. THE PRECAST FLAT TOP MAY BE USED ON ANY MANHOLE. THE ECCENTRIC CONE MAY BE USED WHEN THE MANHOLE "H" HEIGHT IS AT LEAST 8 FT.
3. THE MH RING (FRAME) SHALL BE SET IN A BED OF GROUT. THE FRAME SHALL BE SURROUNDED WITH A CEMENT GROUT IN UNPAVED AREA, OR A CONCRETE COLLAR IN PAVED AREA. SEE DETAILS ON SHEETS 2 AND 3.
4. DESIGN OF BOX BASE IS BASED ON STRAIGHT RUNS OF CONDUIT OR CHANGE IN DIRECTION OF LESS THAN 45°. SPECIAL DESIGN IS REQUIRED FOR 45° OR GREATER.
5. PRECAST MANHOLES AND REINFORCEMENT SHALL CONFORM TO ASTM C 478 (AASHTO M 199).
6. CAST-IN-PLACE MANHOLES SHALL BE CLASS B CONCRETE.
7. STEPS SHALL BE REQUIRED WHEN THE MANHOLE DEPTH EXCEEDS 3 FT.-6 IN. AND SHALL BE IN ACCORDANCE WITH AASHTO M 199.
8. ALL REINFORCING STEEL SHALL HAVE A MINIMUM YIELD STRENGTH OF 60,000 PSI. VERTICAL STEEL SHALL BE PLACED AT ℄ OF WALL. ALL BARS SHALL HAVE A 2 IN.MINIMUM CLEARANCE.
9. ALL PIPE ENTRIES INTO THE BASE OF MANHOLE SHALL BE CONNECTED BY OPEN CHANNELIZATION ADJUSTED FOR PIPE SIZE, SHAPE, SLOPE, AND DIRECTION OF FLOW. DETAILS SHOWN ARE TYPICAL FOR INSTALLATIONS WITH ALL INVERTS OF SAME RELATIVE ELEVATION. FOR EXCESSIVE ELEVATION DIFFERENCE BETWEEN INVERTS, SPECIAL BASE/CHANNEL DETAILS WILL BE SHOWN ON THE PLANS.
10. FLOW CHANNELS AND INVERTS SHALL BE FORMED BY SHAPING WITH CLASS B CONCRETE OR APPROVED GROUT.
11. STUB-OUTS SHALL EXTEND 2 FT. MINIMUM BEYOND OUTSIDE WALL SURFACE OF MANHOLE AND BE SATISFACTORILY PLUGGED.
12. CHECK WITH THE LOCAL GOVERNMENT AUTHORITY FOR ANY ADDITIONAL SANITARY SEWER SPECIFICATIONS, DETAILS, OR REGULATIONS.
13. THE SLOPE OF THE MANHOLE COVER SHALL MATCH THE ROADWAY PROFILE AND CROSS SLOPE.

QUANTITIES FOR CONCRETE MANHOLE BOX BASE

MARK	SIZE	TYPE	WT. #/FT.	BARS	I.D. 54"	60"	66"	72"	84"	96"	FORMULAS
401	4	I	0.668	NO. REQ'D.	18	18	18	18	18	18	401
				LENGTH	8'-1"	8'-8"	9'-3"	9'-10"	11'-0"	12'-2"	BAR LENGTH = 32"+2W+I.D.
				WEIGHT #	97.2	104.2	111.2	118.2	132.3	146.3	
402	4	III	0.668	NO. REQ'D.	5	5	5	5	5	5	402
				LENGTH	5'-5"	6'-0"	6'-7"	7'-2"	8'-4"	9'-6"	BAR LENGTH = I.D. + 2W
				WEIGHT #	18.1	20.0	22.0	23.9	27.8	31.7	
501	5	I	1.043	NO. REQ'D.	17	17	17	17	17	17	501
				LENGTH	7'-5"	8'-0"	8'-7"	9'-2"	10'-4"	11'-6"	BAR LENGTH = 24" + I.D. + 2W
				WEIGHT #	131.5	141.8	152.2	162.5	183.2	203.9	
502	5	I	1.043	NO. REQ'D.	22	23	25	26	29	32	502
				LENGTH	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	NUMBER BARS REQ'D. = $3 + \left(\frac{24+I.D.+2W}{@\ 5"}+1\right)$
				WEIGHT #	114.7	119.9	130.4	135.6	151.2	166.9	
503	5	II	1.043	NO. REQ'D.	16	16	18	18	20	24	503
				LENGTH	12'-10"	13'-5"	14'-0"	14'-7"	15'-9"	16'-11"	NUMBER BARS REQ'D. = $2\left(\frac{13+I.D.+2W}{@\ 12"}+1\right)$
				WEIGHT #	214.2	223.9	262.8	273.8	328.5	423.5	BAR LENGTH = 4'-9"+2(16+W+I.D./2)
504	5	I	1.043	NO. REQ'D.	12	14	14	16	18	20	504
				LENGTH	8'-1"	8'-8"	9'-3"	9'-10"	11'-0"	12'-2"	NUMBER BARS REQ'D. = $2\left(\frac{2W+I.D.-4}{@\ 12"}+1\right)$
				WEIGHT #	101.2	126.6	135.1	164.1	206.5	253.8	BAR LENGTH = 32"+2W+I.D.
1101	11	I	5.313	NO. REQ'D.	4	4	4	4	4	4	1101
				LENGTH	7'-2"	7'-9"	8'-4"	8'-11"	10'-1"	11'-3"	BAR LENGTH = 21" + I.D. + 2W
				WEIGHT #	152.3	164.7	177.1	189.5	214.3	239.1	
1102	11	I	5.313	NO. REQ'D.	4	4	4	4	4	4	BENDING
				LENGTH	2'-8"	2'-8"	2'-8"	2'-8"	2'-8"	2'-8"	TYPE I — STRAIGHT
				WEIGHT #	56.7	56.7	56.7	56.7	56.7	56.7	
1103	11	I	5.313	NO. REQ'D.	3	3	3	3	3	3	TYPE II — 4'-9", 16"+W+I.D./2
				LENGTH	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	5'-0"	
				WEIGHT #	79.7	79.7	79.7	79.7	79.7	79.7	TYPE III — 12", 12", 7", I.D.+2W-38"
REINFORCING STEEL TOTAL #					985.6	1,037.5	1,127.2	1,204.0	1,380.2	1,601.8	
CONCRETE – CUBIC YARDS – TOTAL					6.0	6.6	7.3	8.0	9.5	11.1	

NOTE: QUANTITIES ARE BASED ON SAME SIZE PIPE ENTRANCE TO AND EXIT FROM, BASE AND A 4 FT. MANHOLE ENTRANCE INTO TOP SLAB OF BASE.

Colorado Department of Transportation
4201 East Arkansas Avenue
Denver, Colorado 80222
Phone: (303) 757-9083 FAX: (303) 757-9820
Project Development Branch SD

Computer File Information
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Drawing File Name: 6040200103.dwg
Acad Version: R14 Scale: NA Units: English

Standard Plan Revised

Date:	Comments:

MANHOLES

Issued By: Project Development Branch October 1, 2000

STANDARD PLAN NO.
M-604-20
Sheet No. 1 of 3

J3 Engineering Consultants Inc.
3151 S. Vaughn Way, Suite 680
Aurora, CO 80014
Tel: 303-368-5601 Fax: 303-368-5603

DESIGNED BY: JRD DATE: 11/14/08
DRAWN BY: JAN DATE: 02/28/09
CHECKED BY: KSC DATE: 04/17/09

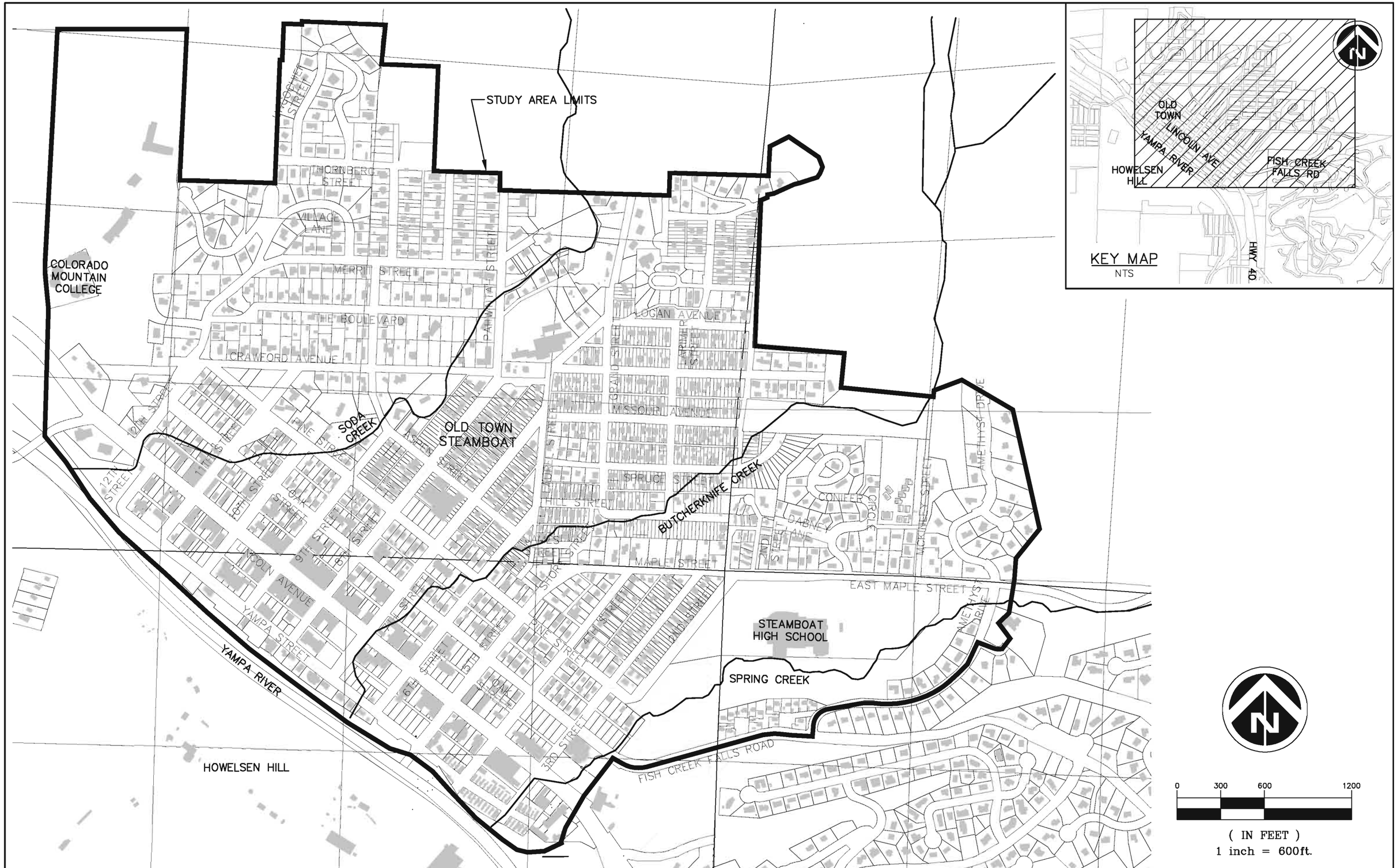
CITY OF STEAMBOAT SPRINGS

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS

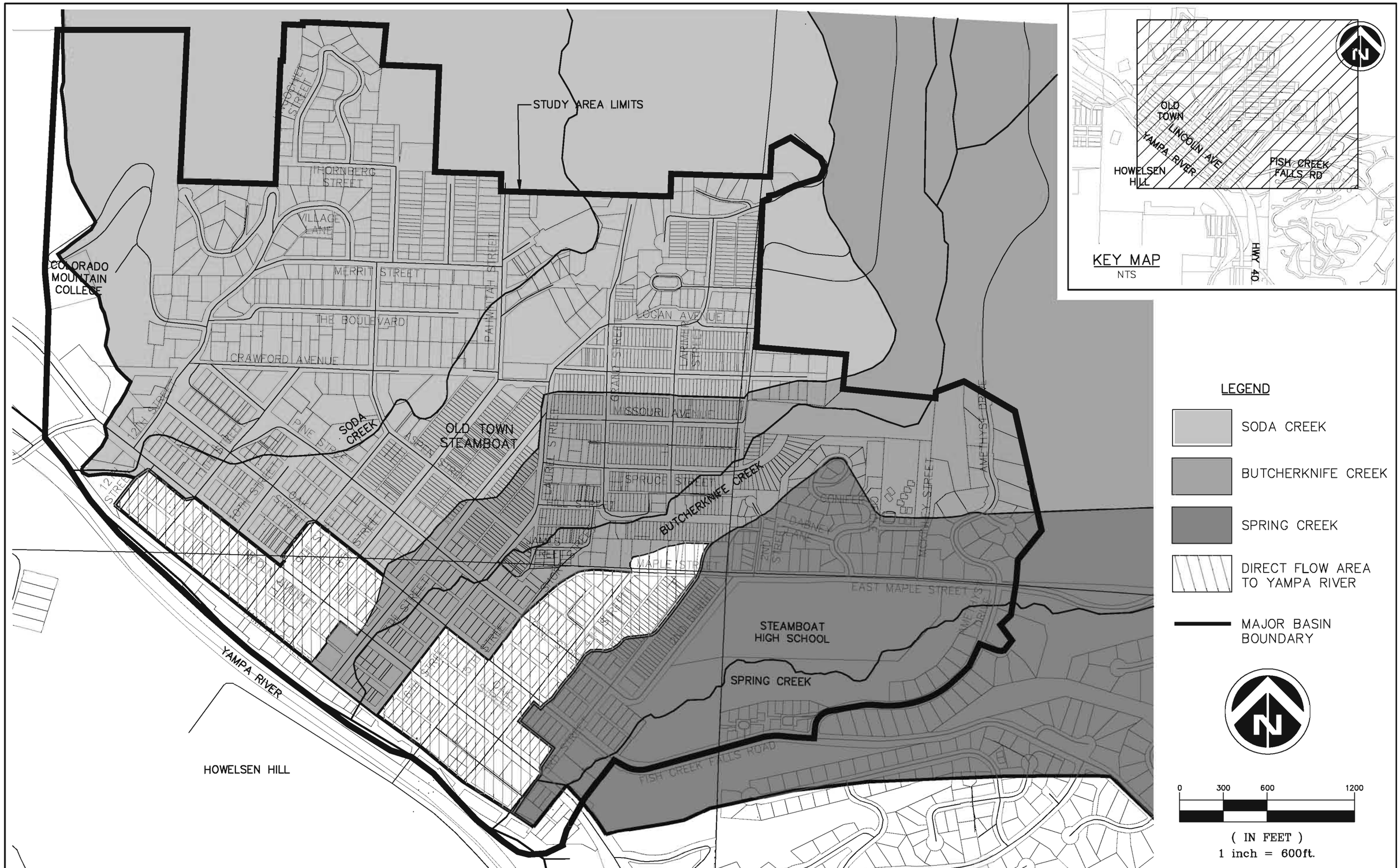
TYPICAL DETAILS

FIGURE A10

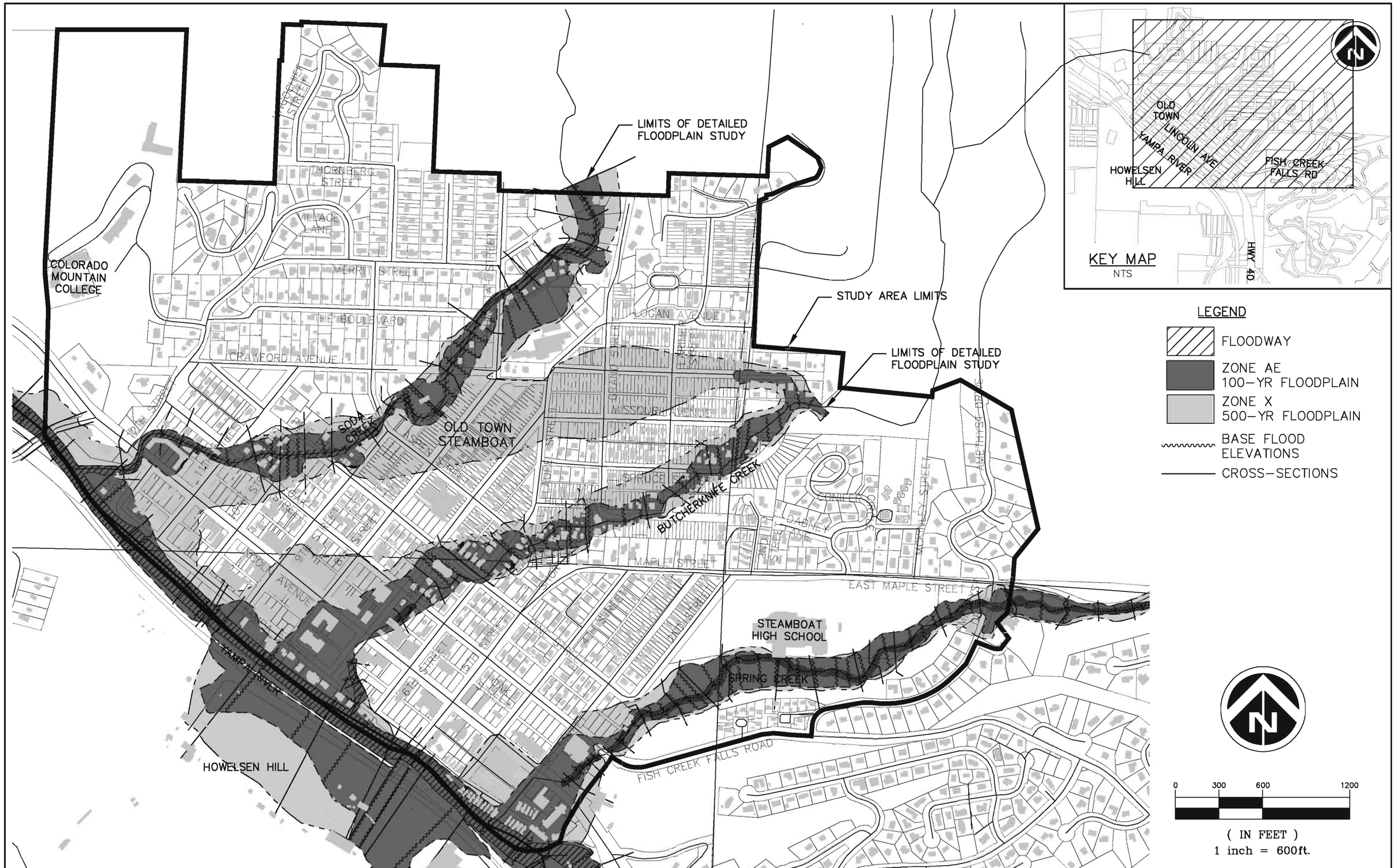
APPENDIX B:
GENERAL FIGURES



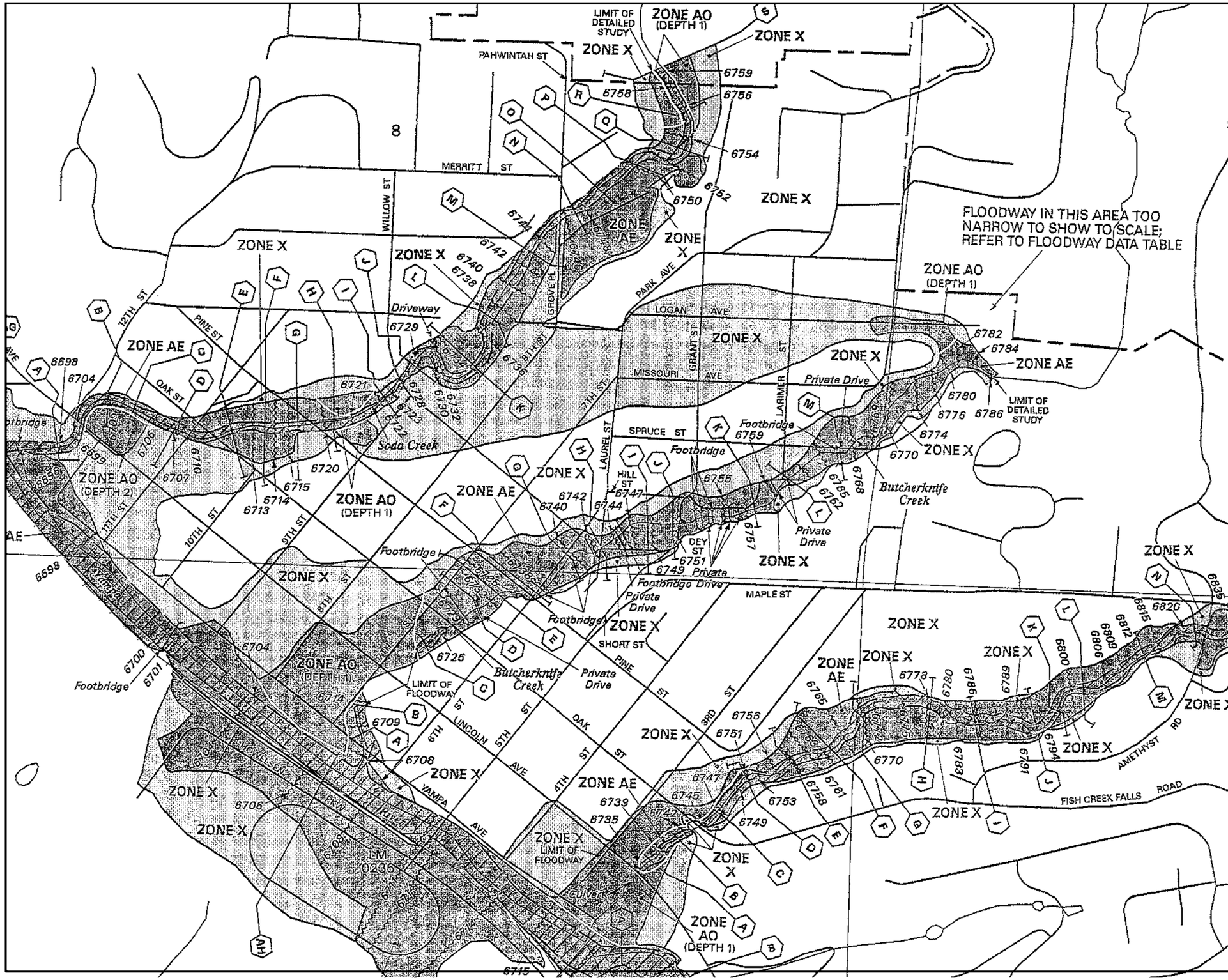
J3 Engineering Consultants Inc. 3151 S. Vaughn Way, Suite 680 Aurora, CO 80014 Tel: 303-368-5601 Fax: 303-368-5603	DESIGNED BY: JRD DRAWN BY: JAN CHECKED BY: KSC	DATE: 11/14/08 DATE: 02/28/09 DATE: 04/17/09	CITY OF STEAMBOAT SPRINGS	OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS	STUDY AREA MAP FIGURE B1



J3 Engineering Consultants Inc. 3151 S. Vaughn Way, Suite 680 Aurora, CO 80014 Tel: 303-368-5601 Fax: 303-368-5603	DESIGNED BY: JRD DRAWN BY: JAN CHECKED BY: KSC	DATE: 11/14/08 DATE: 02/28/09 DATE: 04/17/09	CITY OF STEAMBOAT SPRINGS	OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS	WATERSHED MAP	FIGURE B2



J3 Engineering Consultants Inc. 3151 S. Vaughn Way, Suite 680 Aurora, CO 80014 Tel: 303-368-5601 Fax: 303-368-5603	DESIGNED BY: JRD DRAWN BY: JAN CHECKED BY: KSC	DATE: 11/14/08 DATE: 02/28/09 DATE: 04/17/09	CITY OF STEAMBOAT SPRINGS	OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS	EFFECTIVE FEMA FLOODPLAIN DELINEATION	FIGURE B3



MAP SCALE 1" = 500'

500 1000 FEET

METERS

PANEL 0877D

FIRM
FLOOD INSURANCE RATE MAP
ROUTT COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 877 OF 1475

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ROUTT COUNTY, UNINCORPORATED AREAS	080156	0877	D
STEAMBOAT SPRINGS, CITY OF	080158	0877	D

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

MAP NUMBER
08107C0877D

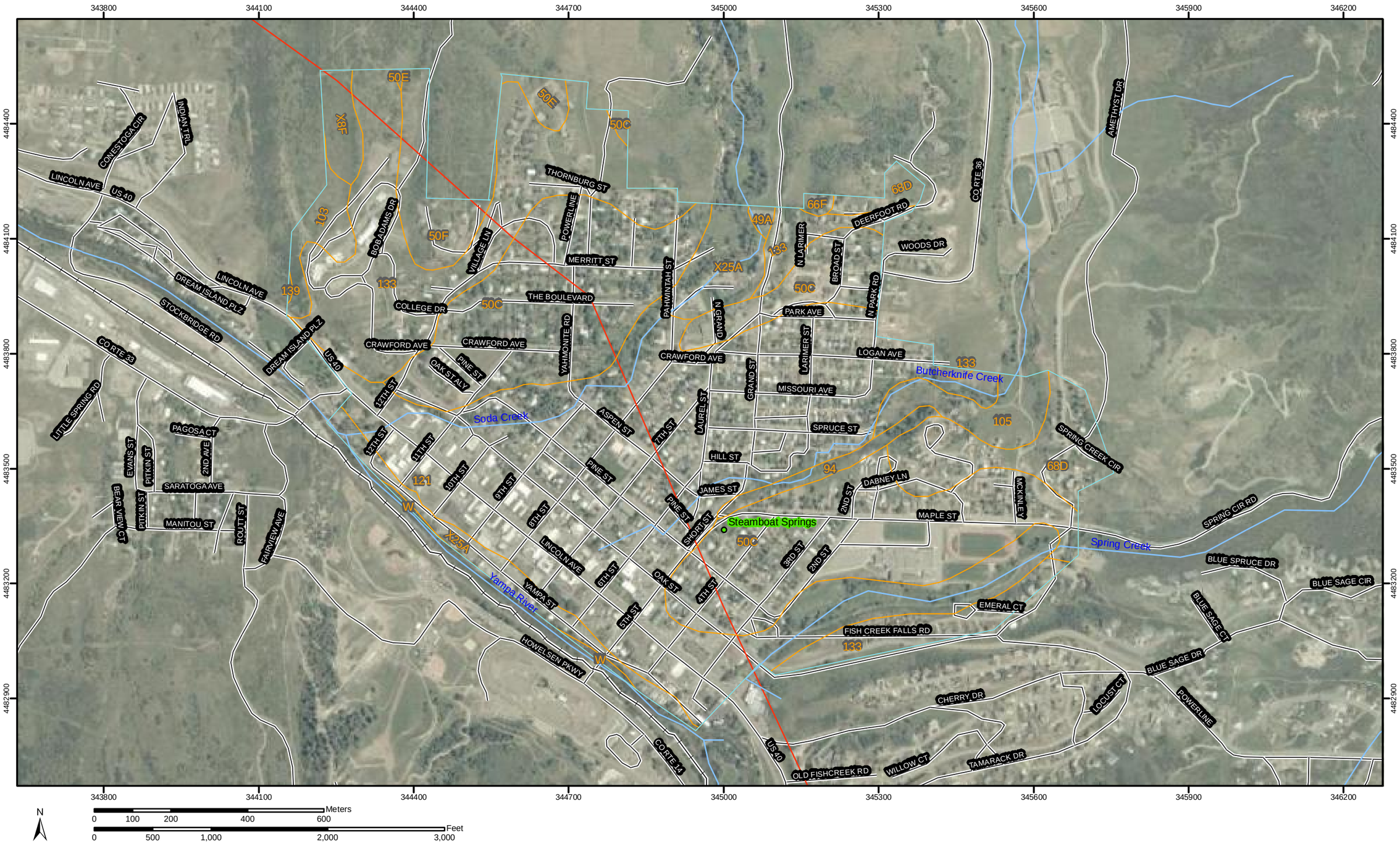
EFFECTIVE DATE:
FEBRUARY 4, 2005

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

FIGURE B4

Soil Map–Routt Area, Colorado, Parts of Rio Blanco and Routt Counties
(Old Town Steamboat Springs)



Natural Resources Conservation Service

Web Soil Survey 2.0
National Cooperative Soil Survey

11/10/2008
Page 1 of 3

FIGURE B5

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Units

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Gully

Short Steep Slope

Other

Political Features

Municipalities

Cities

Urban Areas

Water Features

Oceans

Streams and Canals

Transportation

Rails

Roads

Interstate Highways

US Routes

State Highways

Local Roads

Other Roads

MAP INFORMATION

Original soil survey map sheets were prepared at publication scale. Viewing scale and printing scale, however, may vary from the original. Please rely on the bar scale on each map sheet for proper map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 13N

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

Soil Survey Area: Routt Area, Colorado, Parts of Rio Blanco and Routt Counties
Survey Area Data: Version 4, Sep 25, 2007

Date(s) aerial images were photographed: 1999

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

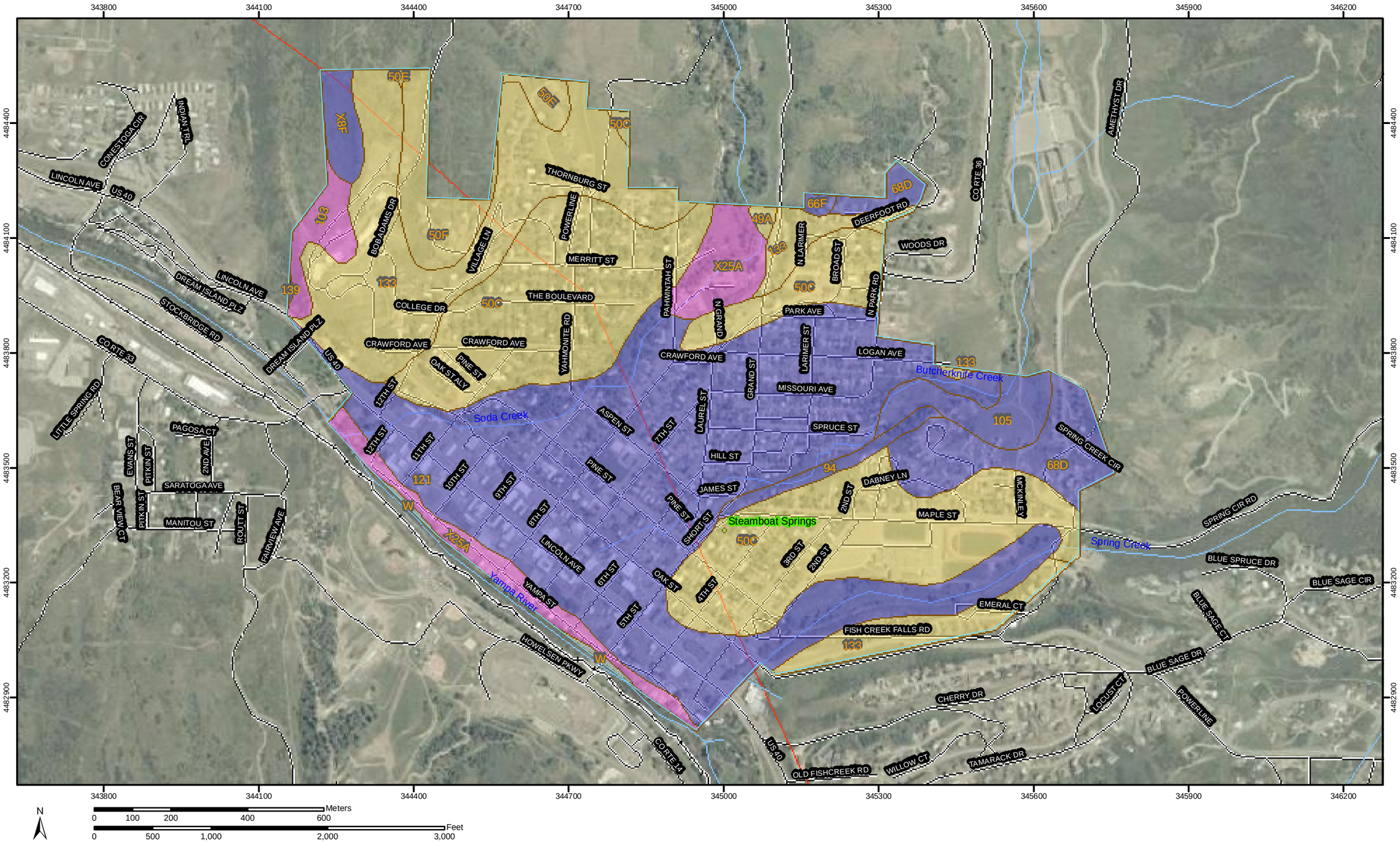
FIGURE B6

Map Unit Legend

Routt Area, Colorado, Parts of Rio Blanco and Routt Counties (CO648)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
49A	Menbar, gravelly substratum, 0 to 3 percent slopes	1.0	0.2%
50C	Lintim loam, 3 to 12 percent slopes	143.4	26.7%
50E	Lintim loam, 12 to 25 percent slopes	3.7	0.7%
50F	Routt loam, warm, 25 to 65 percent slopes	14.6	2.7%
66F	Foidel loam, 25 to 65 percent slopes	1.0	0.2%
68D	Rabbitears loam, 12 to 25 percent slopes	26.0	4.8%
94	Peeler-Pagosa complex, 30 to 65 percent slopes	5.2	1.0%
103	Cryoborolls, cryorthents soils, rock outcrop, 25 to 99 percent slopes	7.6	1.4%
105	Rabbitears very gravelly sandy loam, 30 to 50 percent slopes	12.3	2.3%
121	Handran loam, 0 to 5 percent slopes	200.4	37.3%
133	Lintim loam, cool, 3 to 25 percent slopes	90.0	16.8%
139	Samrock gravelly loam, 3 to 25 percent slopes, very stony	0.2	0.0%
W	Water	1.1	0.2%
X8F	Dunckley-Skyway complex, 25 to 65 percent slopes	6.1	1.1%
X25A	Toponas loam, 0 to 3 percent slopes	24.9	4.6%
Totals for Area of Interest (AOI)		537.5	100.0%

FIGURE B7

Hydrologic Soil Group–Routt Area, Colorado, Parts of Rio Blanco and Routt Counties
(Old Town Steamboat Springs)



N

Meters
0 100 200 400 600

Feet
0 500 1,000 2,000 3,000

Natural Resources Conservation Service

Web Soil Survey 2.0
National Cooperative Soil Survey

11/10/2008
Page 1 of 4

FIGURE B8

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Units

Soil Ratings

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Political Features

Municipalities

Cities

Urban Areas

Water Features

Oceans

Streams and Canals

Transportation

Rails

Roads

Interstate Highways

US Routes

State Highways

Local Roads

Other Roads

MAP INFORMATION

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Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 13N

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

Soil Survey Area: Routt Area, Colorado, Parts of Rio Blanco and Routt Counties
Survey Area Data: Version 4, Sep 25, 2007

Date(s) aerial images were photographed: 1999

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

FIGURE B9

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Routt Area, Colorado, Parts of Rio Blanco and Routt Counties				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
49A	Menbar, gravelly substratum, 0 to 3 percent slopes	C	1.0	0.2%
50C	Lintim loam, 3 to 12 percent slopes	C	143.4	26.7%
50E	Lintim loam, 12 to 25 percent slopes	C	3.7	0.7%
50F	Routt loam, warm, 25 to 65 percent slopes	C	14.6	2.7%
66F	Foidel loam, 25 to 65 percent slopes	B	1.0	0.2%
68D	Rabbitears loam, 12 to 25 percent slopes	B	26.0	4.8%
94	Peeler-Pagosa complex, 30 to 65 percent slopes	B	5.2	1.0%
103	Cryoborolls, cryorthents soils, rock outcrop, 25 to 99 percent slopes	D	7.6	1.4%
105	Rabbitears very gravelly sandy loam, 30 to 50 percent slopes	B	12.3	2.3%
121	Handran loam, 0 to 5 percent slopes	B	200.4	37.3%
133	Lintim loam, cool, 3 to 25 percent slopes	C	90.0	16.8%
139	Samrock gravelly loam, 3 to 25 percent slopes, very stony	B	0.2	0.0%
W	Water		1.1	0.2%
X8F	Dunckley-Skyway complex, 25 to 65 percent slopes	B	6.1	1.1%
X25A	Toponas loam, 0 to 3 percent slopes	D	24.9	4.6%
Totals for Area of Interest (AOI)			537.5	100.0%

Description

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

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

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

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

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

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

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

Rating Options

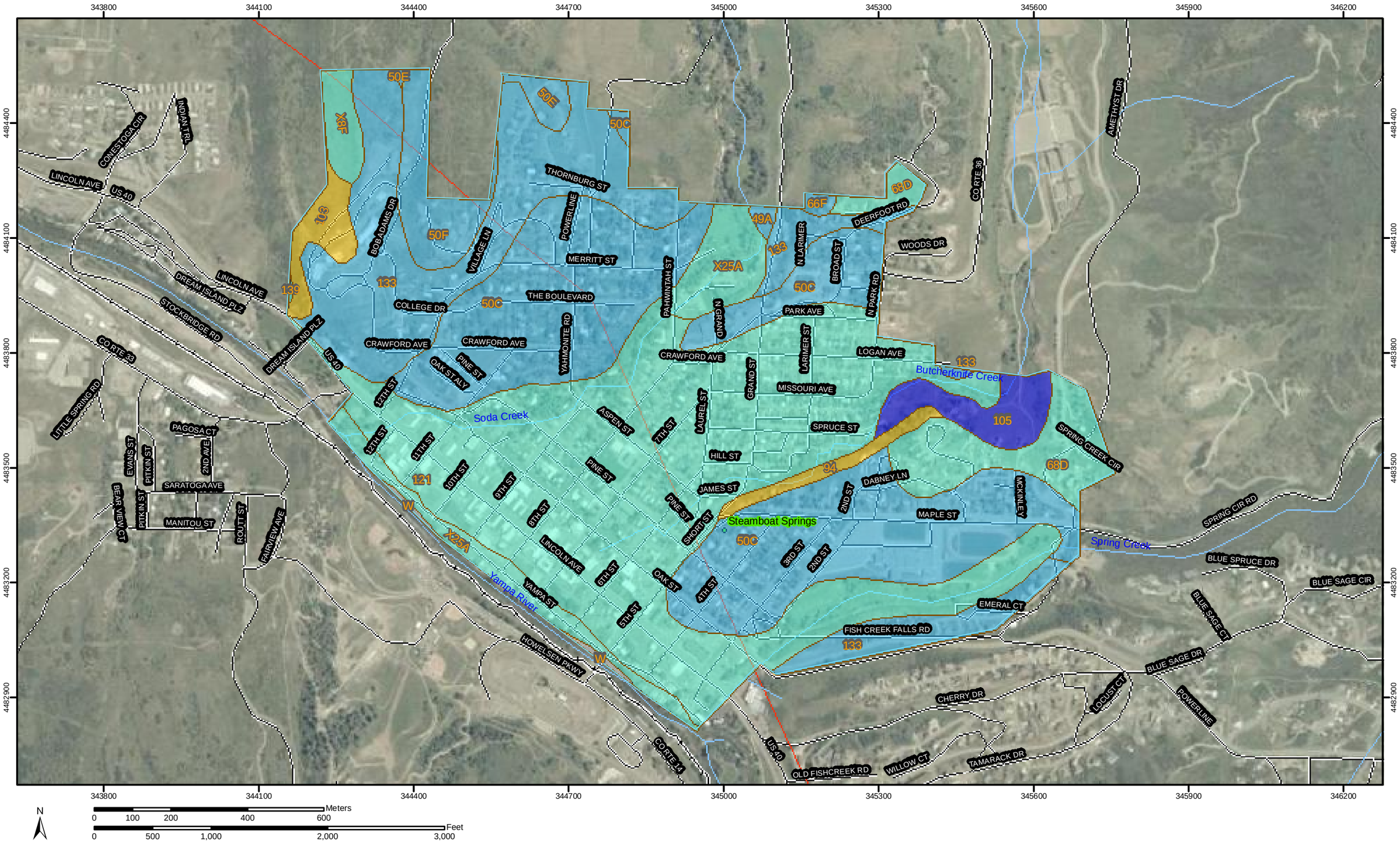
Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Lower

FIGURE B10

Wind Erodibility Group–Routt Area, Colorado, Parts of Rio Blanco and Routt Counties
(Old Town Steamboat Springs)



Natural Resources Conservation Service

Web Soil Survey 2.0
National Cooperative Soil Survey

11/10/2008
Page 1 of 4

FIGURE B11

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Units

Soil Ratings

1

2

3

4

4L

5

6

7

8

Not rated or not available

Political Features

Municipalities

Cities

Urban Areas

Water Features

Oceans

Streams and Canals

Transportation

Rails

Roads

Interstate Highways

US Routes

State Highways

Local Roads

Other Roads

MAP INFORMATION

Original soil survey map sheets were prepared at publication scale. Viewing scale and printing scale, however, may vary from the original. Please rely on the bar scale on each map sheet for proper map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 13N

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

Soil Survey Area: Routt Area, Colorado, Parts of Rio Blanco and Routt Counties
Survey Area Data: Version 4, Sep 25, 2007

Date(s) aerial images were photographed: 1999

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

FIGURE B12

Wind Erodibility Group

Wind Erodibility Group— Summary by Map Unit — Routt Area, Colorado, Parts of Rio Blanco and Routt Counties				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
49A	Menbar, gravelly substratum, 0 to 3 percent slopes	6	1.0	0.2%
50C	Lintim loam, 3 to 12 percent slopes	6	143.4	26.7%
50E	Lintim loam, 12 to 25 percent slopes	6	3.7	0.7%
50F	Routt loam, warm, 25 to 65 percent slopes	6	14.6	2.7%
66F	Foidel loam, 25 to 65 percent slopes	6	1.0	0.2%
68D	Rabbitears loam, 12 to 25 percent slopes	5	26.0	4.8%
94	Peeler-Pagosa complex, 30 to 65 percent slopes	3	5.2	1.0%
103	Cryoborolls, cryorthents solls, rock outcrop, 25 to 99 percent slopes	3	7.6	1.4%
105	Rabbitears very gravelly sandy loam, 30 to 50 percent slopes	8	12.3	2.3%
121	Handran loam, 0 to 5 percent slopes	5	200.4	37.3%
133	Lintim loam, cool, 3 to 25 percent slopes	6	90.0	16.8%
139	Samrock gravelly loam, 3 to 25 percent slopes, very stony	5	0.2	0.0%
W	Water		1.1	0.2%
X8F	Dunckley-Skyway complex, 25 to 65 percent slopes	5	6.1	1.1%
X25A	Toponas loam, 0 to 3 percent slopes	5	24.9	4.6%
Totals for Area of Interest (AOI)			537.5	100.0%

Description

A wind erodibility group (WEG) consists of soils that have similar properties affecting their susceptibility to wind erosion in cultivated areas. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible.

Rating Options

Aggregation Method: Dominant Condition

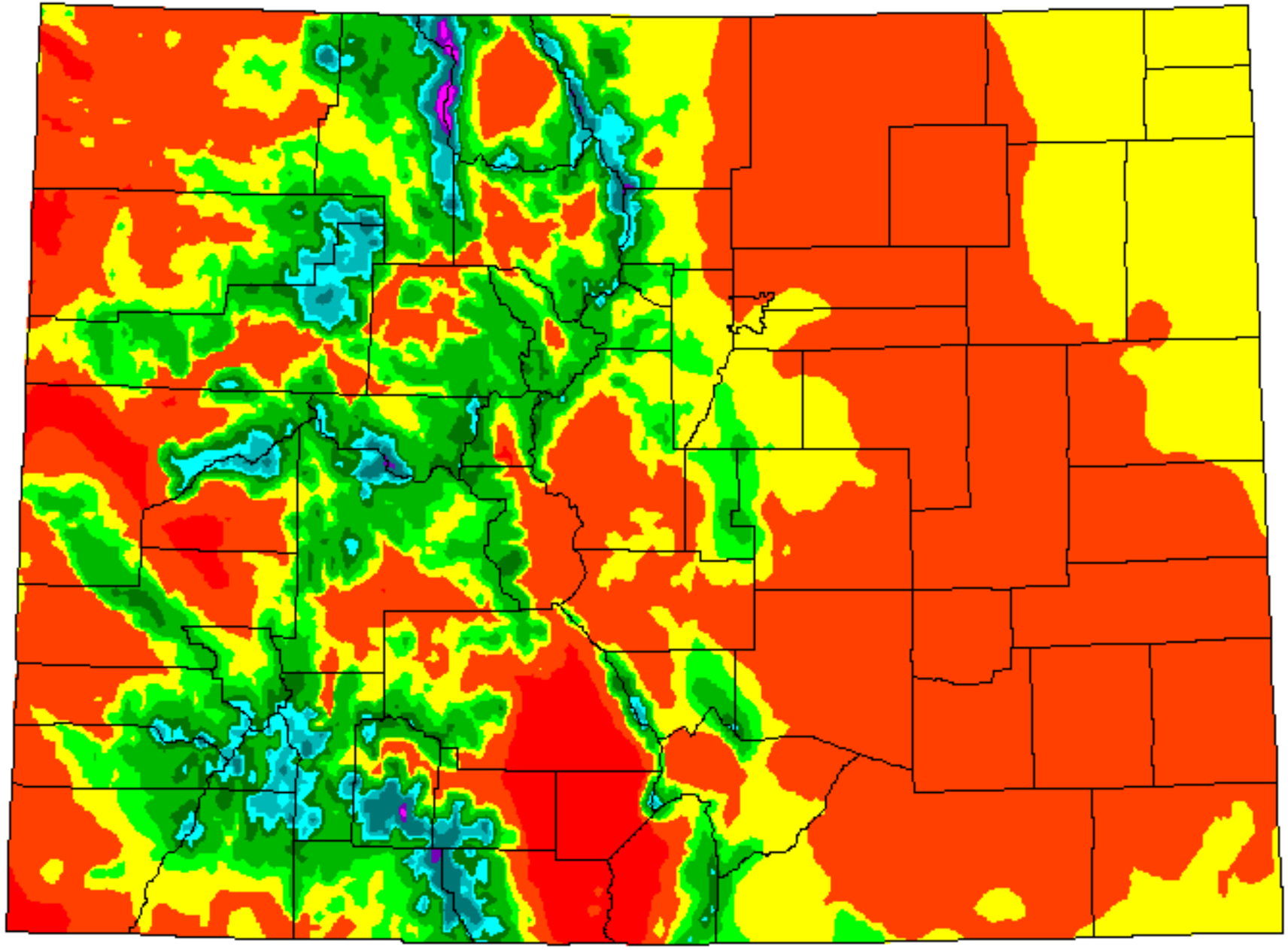
Component Percent Cutoff: *None Specified*

Tie-break Rule: Lower

FIGURE B13

Average Annual Precipitation

Colorado



Legend (in inches)

- Under 10
- 10 to 15
- 15 to 20
- 20 to 25
- 25 to 30
- 30 to 35
- 35 to 40
- 40 to 45
- 45 to 50
- 50 to 55
- Above 55

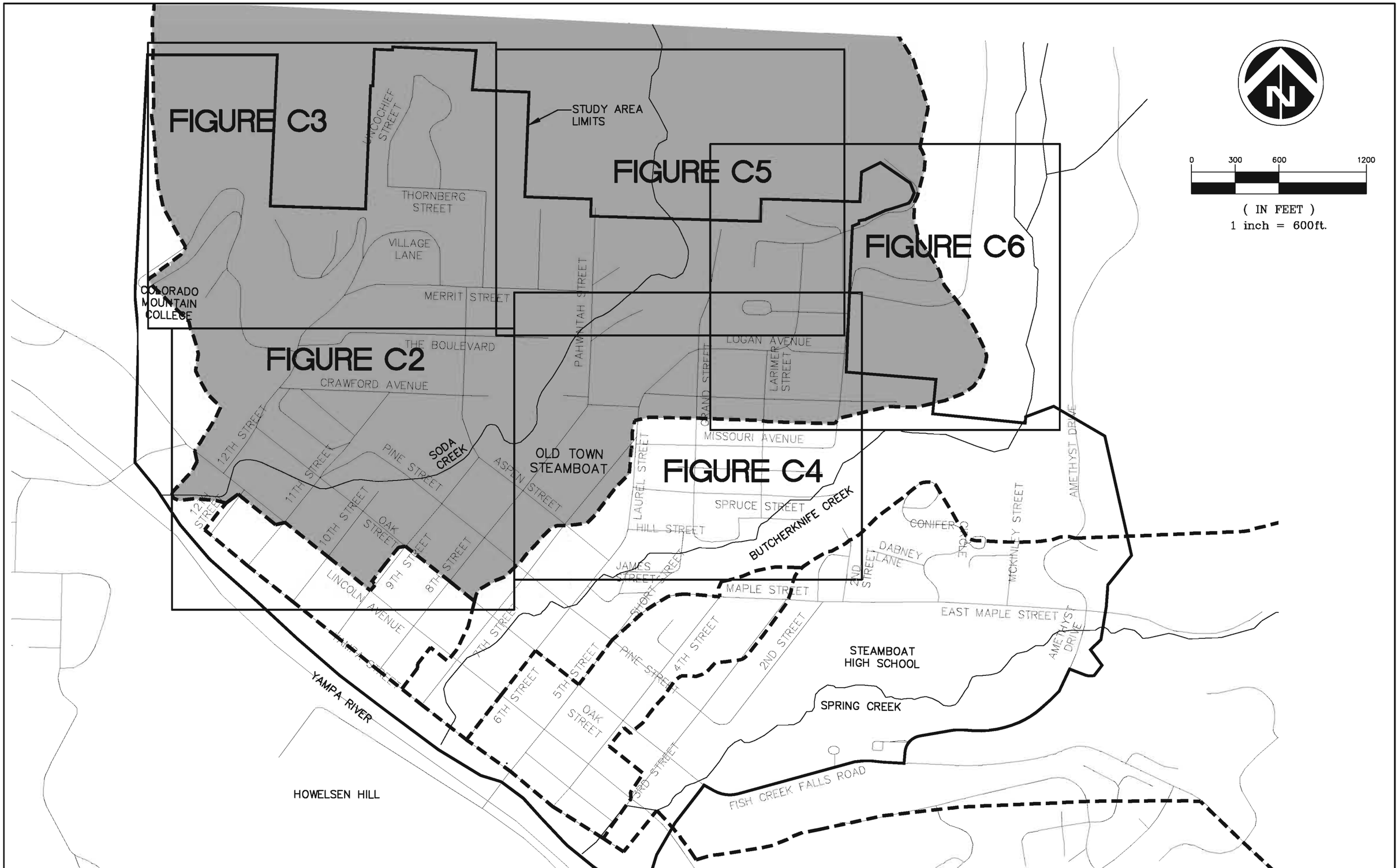
Period: 1961-1990

This map is a plot of 1961-1990 annual average precipitation contours from NOAA Cooperative stations and (where appropriate) USDA-NRCS SNOTEL stations. Christopher Daly used the PRISM model to generate the gridded estimates from which this map was derived; the modeled grid was approximately 4x4 km latitude/longitude, and was resampled to 2x2 km using a Gaussian filter. Mapping was performed by Jenny Weisburg. Funding was provided by USDA-NRCS National Water and Climate Center.

12/8/97

FIGURE B14

APPENDIX C:
HYDROLOGIC ANALYSIS AND SUPPORTING DOCUMENTATION



J3 Engineering Consultants Inc. 3151 S. Vaughn Way, Suite 680 Aurora, CO 80014 Tel: 303-368-5601 Fax: 303-368-5603	DESIGNED BY: JRD DRAWN BY: JAN CHECKED BY: KSC	DATE: 11/14/08 DATE: 02/28/09 DATE: 04/17/09	CITY OF STEAMBOAT SPRINGS	OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS	DRAINAGE KEYMAP FOR SODA CREEK	FIGURE C1

SEE FIGURE C3

THE BOULEVARD

SO-STM LATERAL 3

CRAWFORD AVENUE

SO-STM LATERAL 1

STM

SODA CREEK

SEE FIGURE C4

SO-STM LATERAL 2

10TH STREET

11TH STREET

OAK STREET

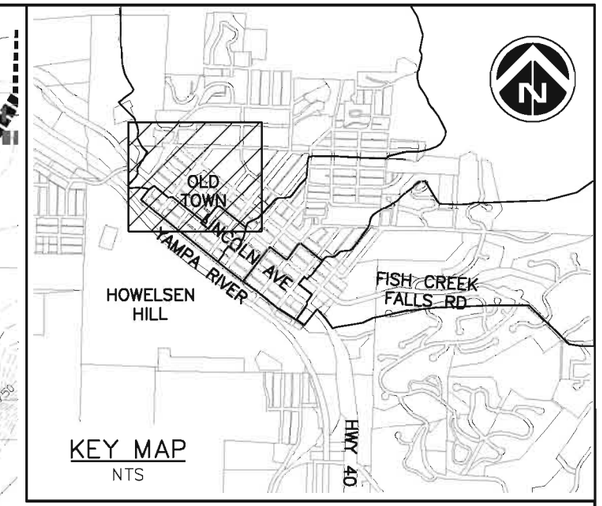
PINE STREET

LINCOLN AVENUE

SO-STM LATERAL 5

YAMPA RIVER

STUDY AREA LIMITS



LEGEND

DESIGN POINT MINOR BASIN	A1 — RUNOFF COEFFICIENTS
BASIN I.D.	SO-C5
TRIBUTARY AREA (ACRES)	4.06
EXISTING MAJOR & MINOR CONTOURS	5180
PROPOSED STORM SEWER WITH MH & INLET	
EXISTING STORM SEWER WITH MH & INLET	
STUDY AREA LIMITS	
MAJOR BASIN BOUNDARY	
MINOR BASIN BOUNDARY	
SUB-BASIN BOUNDARY	

NOTES:

1. FOR PRELIMINARY STORM SEWER LAYOUT, SIZES, AND DESIGN INFORMATION PLEASE REFER TO THE FIGURES PROVIDED IN APPENDIX D. STORM SEWER INCLUDED ON THESE SHEETS FOR ILLUSTRATIVE PURPOSES AND TO ASSIST WITH DEPICTING HYDROLOGIC ROUTING.
2. FOR PRELIMINARY CHANNEL IMPROVEMENTS AND DESIGN INFORMATION PLEASE REFER TO THE FIGURES PROVIDED IN APPENDIX D.

0 100 200 400

(IN FEET)
1 inch = 200ft.

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STUDY AREA LIMITS

BASIN DELINEATION DETERMINED FROM USGS TOPOGRAPHIC QUAD MAPS.

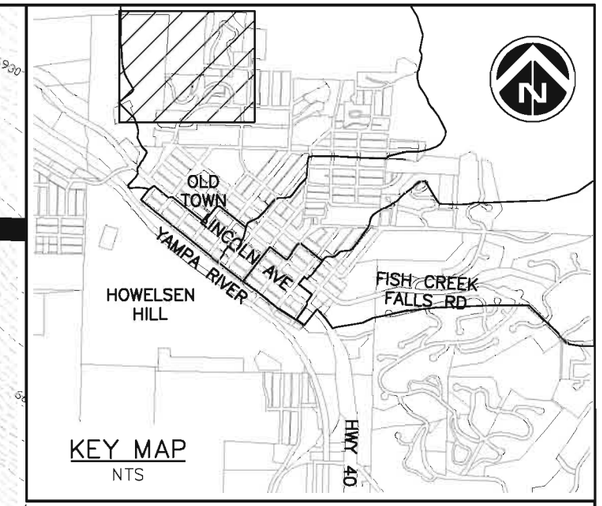
STM

VILLAGE LANE

COLORADO MOUNTAIN COLLEGE

SEE FIGURE C5

SEE FIGURE C2



KEY MAP
NTS

LEGEND

DESIGN POINT
MINOR BASIN — A1 — RUNOFF COEFFICIENTS

BASIN I.D. → SO-C5
TRIBUTARY AREA (ACRES) → 4.06

EXISTING MAJOR & MINOR CONTOURS — 5180
PROPOSED STORM SEWER WITH MH & INLET
EXISTING STORM SEWER WITH MH & INLET
STUDY AREA LIMITS
MAJOR BASIN BOUNDARY
MINOR BASIN BOUNDARY
SUB-BASIN BOUNDARY

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0 100 200 400

(IN FEET)
1 inch = 200ft.

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SEE FIGURE C5

SEE FIGURE C2

STM

STM

SO-STM
LATERAL 4

WEST LOGAN AVENUE

GRANT STREET

LARIMER STREET

MISSOURI AVENUE

STM

STM

OLD TOWN STEAMBOAT

REFER TO BUTCHERKNIFE CREEK
DETAILED DRAINAGE MAP

SPRUCE STREET

ASPEN STREET

LAUREL STREET

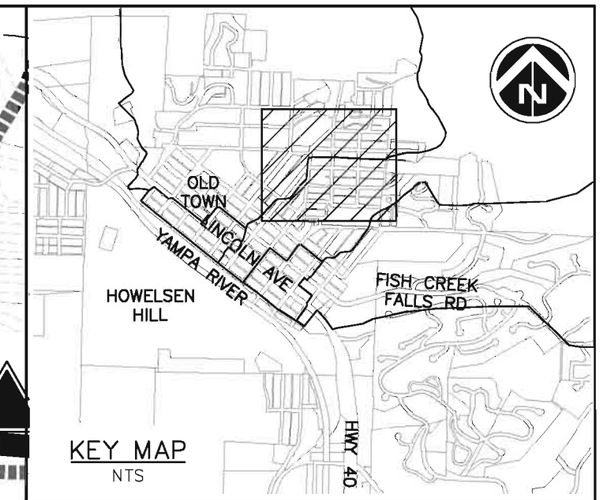
HILL STREET

STM

JAMES STREET

BUTCHERKNIFE CREEK

STREET



KEY MAP
NTS

LEGEND

DESIGN POINT MINOR BASIN	A1 — RUNOFF COEFFICIENTS
BASIN I.D.	SO-C5
TRIBUTARY AREA (ACRES)	4.06
EXISTING MAJOR & MINOR CONTOURS	5180
PROPOSED STORM SEWER WITH MH & INLET	
EXISTING STORM SEWER WITH MH & INLET	
STUDY AREA LIMITS	
MAJOR BASIN BOUNDARY	
MINOR BASIN BOUNDARY	
SUB-BASIN BOUNDARY	

NOTES:

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0 100 200 400

(IN FEET)
1 inch = 200ft.

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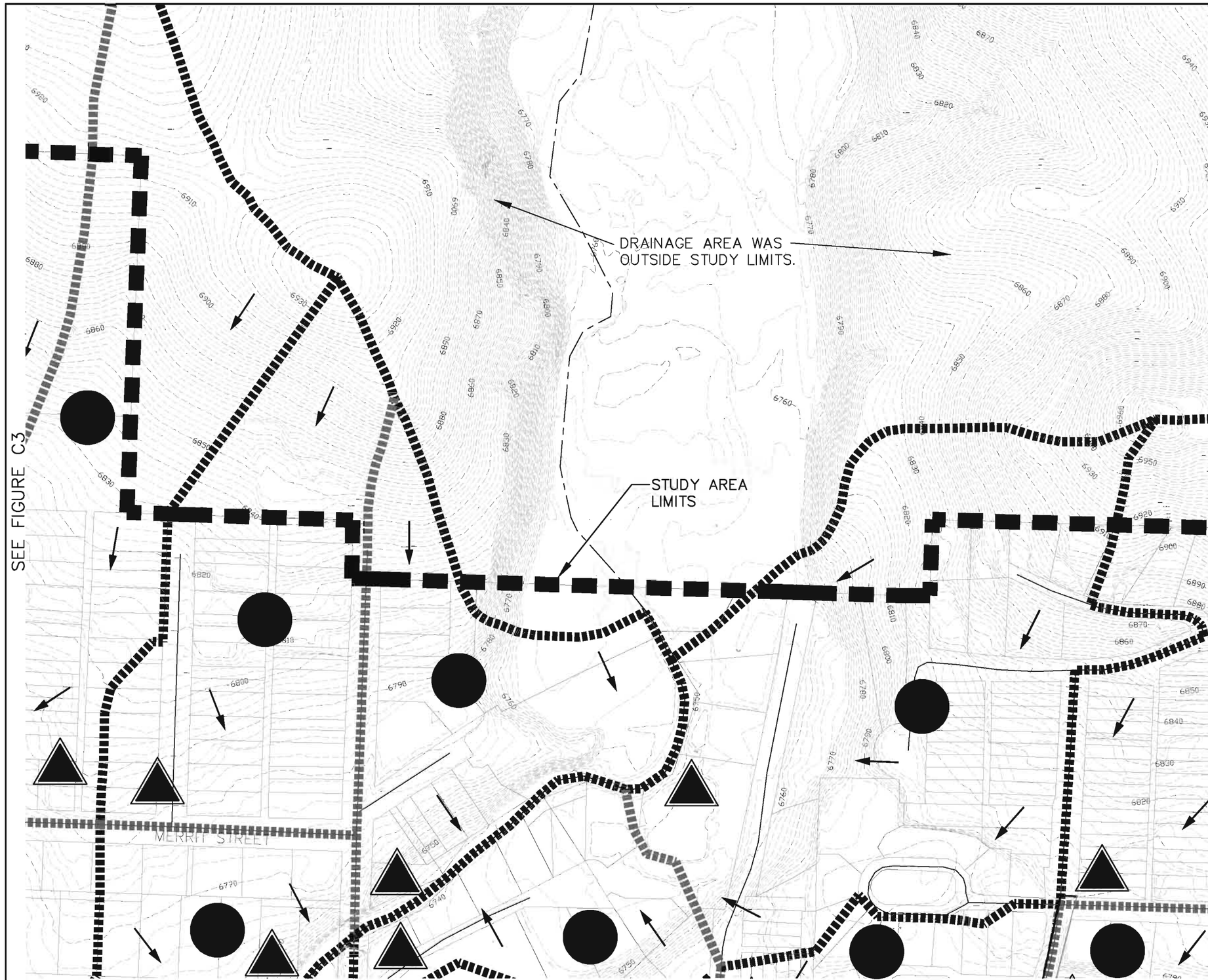
DRAWN BY: JAN	DATE: 02/28/09	
CHECKED BY: KSC	DATE: 04/17/09	

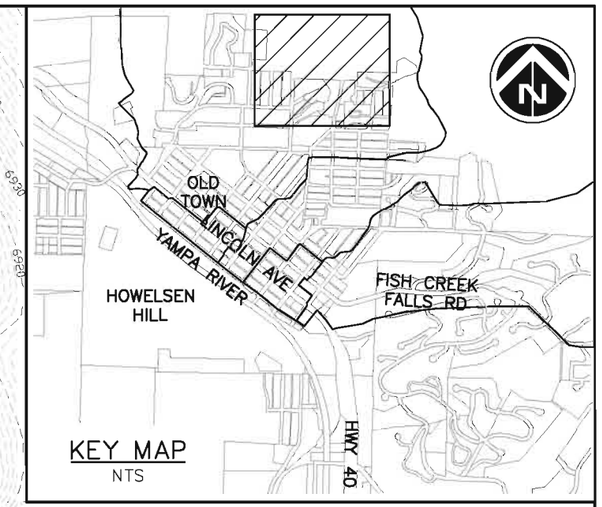
CITY OF STEAMBOAT SPRINGS

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS

SODA CREEK DETAILED DRAINAGE MAP

FIGURE C4





LEGEND

DESIGN POINT MINOR BASIN	A1 — RUNOFF COEFFICIENTS
BASIN I.D.	SO-C5
TRIBUTARY AREA (ACRES)	4.06
EXISTING MAJOR & MINOR CONTOURS	5180
PROPOSED STORM SEWER WITH MH & INLET	
EXISTING STORM SEWER WITH MH & INLET	
STUDY AREA LIMITS	
MAJOR BASIN BOUNDARY	
MINOR BASIN BOUNDARY	
SUB-BASIN BOUNDARY	

NOTES:

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0 100 200 400

(IN FEET)
1 inch = 200ft.

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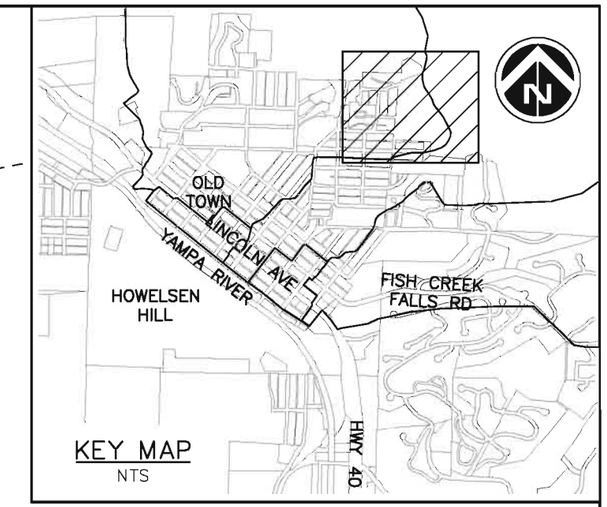
DRAWN BY:	JAN	DATE:	02/28/09
CHECKED BY:	KSC	DATE:	04/17/09

CITY OF STEAMBOAT SPRINGS

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS

SODA CREEK DETAILED DRAINAGE MAP

FIGURE C5



LEGEND

DESIGN POINT MINOR BASIN	A1 — RUNOFF COEFFICIENTS
BASIN I.D.	SO-C5
TRIBUTARY AREA (ACRES)	4.06
EXISTING MAJOR & MINOR CONTOURS	5180
PROPOSED STORM SEWER WITH MH & INLET	
EXISTING STORM SEWER WITH MH & INLET	
STUDY AREA LIMITS	
MAJOR BASIN BOUNDARY	
MINOR BASIN BOUNDARY	
SUB-BASIN BOUNDARY	

NOTES:

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0 100 200 400

(IN FEET)
1 inch = 200ft.

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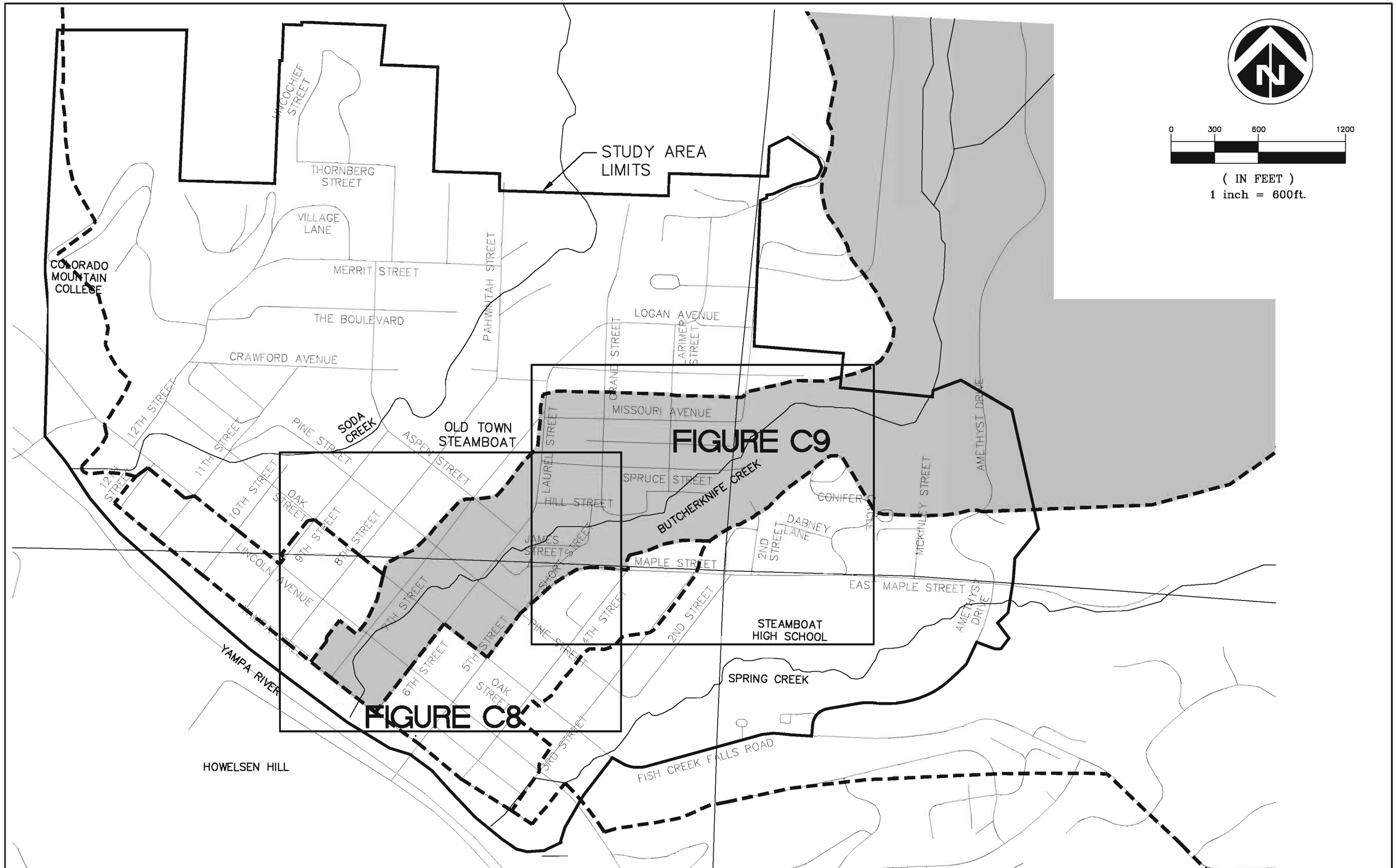
CHECKED BY:	KSC	DATE: 04/17/09

CITY OF STEAMBOAT SPRINGS

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS

SODA CREEK DETAILED DRAINAGE MAP

FIGURE C6



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SEE FIGURE C9

BUTCHERKNIFE CREEK DIVERSON PIPE

SO-STM LATERAL 2

REFER TO SODA CREEK DETAILED DRAINAGE MAP

REFER TO DFA-YAMPA DETAILED DRAINAGE MAP

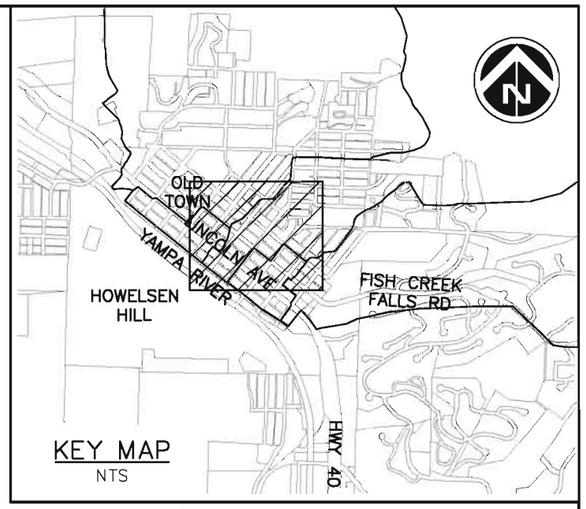
REFER TO DFA-YAMPA DETAILED DRAINAGE MAP

REFER TO SPRING CREEK DETAILED DRAINAGE MAP

SEE FIGURE C9

STUDY AREA LIMITS

OAK STREET
PINE STREET
ASPEN STREET
LAUREL STREET
HILL STREET
SHORT STREET
LINCOLN AVENUE
YAMPA RIVER
BUTCHERKNIFE CREEK
STM



LEGEND

DESIGN POINT
MINOR BASIN — A1 — RUNOFF COEFFICIENTS

BASIN I.D. → SO-C5
TRIBUTARY AREA (ACRES) → 4.06

EXISTING MAJOR & MINOR CONTOURS — 5180

PROPOSED STORM SEWER WITH MH & INLET

EXISTING STORM SEWER WITH MH & INLET

STUDY AREA LIMITS

MAJOR BASIN BOUNDARY

MINOR BASIN BOUNDARY

SUB-BASIN BOUNDARY

NOTES:

1. FOR PRELIMINARY STORM SEWER LAYOUT, SIZES, AND DESIGN INFORMATION PLEASE REFER TO THE FIGURES PROVIDED IN APPENDIX D. STORM SEWER INCLUDED ON THESE SHEETS FOR ILLUSTRATIVE PURPOSES AND TO ASSIST WITH DEPICTING HYDROLOGIC ROUTING.
2. FOR PRELIMINARY CHANNEL IMPROVEMENTS AND DESIGN INFORMATION PLEASE REFER TO THE FIGURES PROVIDED IN APPENDIX D.

0 100 200 400

(IN FEET)
1 inch = 200ft.

J3 Engineering Consultants Inc. 3151 S. Vaughn Way, Suite 680 Aurora, CO 80014 Tel: 303-368-5601 Fax: 303-368-5603	DESIGNED BY: JRD DATE: 11/14/08 DRAWN BY: JAN DATE: 02/28/09 CHECKED BY: KSC DATE: 04/17/09	CITY OF STEAMBOAT SPRINGS	OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS	BUTCHERKNIFE CREEK DETAILED DRAINAGE MAP	FIGURE C8

SEE FIGURE C8

SO-STM LATERAL 4

WEST LOGAN AVENUE

GRAND STREET

LARIMER STREET

REFER TO SODA CREEK DETAILED DRAINAGE MAP

MISSOURI AVENUE

STM

BUTCHERKNIFE CREEK DIVERSON PIPE

SPRUCE STREET

LAUREL STREET

HILL STREET

CONIFER

DABNEY LANE

BUTCHERKNIFE CREEK

REFER TO SPRING CREEK DETAILED DRAINAGE MAP

2ND STREET

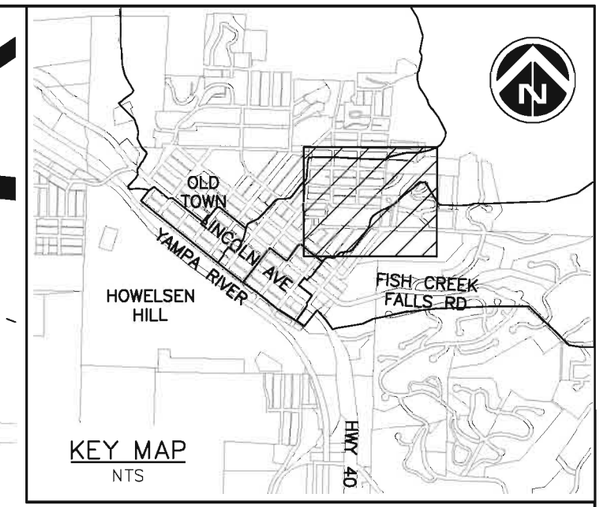
SHORT STREET

MAPLE STREET

EAST MAPLE

REFER TO DFA-YAMPA DETAILED DRAINAGE MAP

STEAMBOAT HIGH SCHOOL



KEY MAP
NTS

LEGEND

DESIGN POINT MINOR BASIN	A1
RUNOFF COEFFICIENTS	
BASIN I.D.	SO-C5
TRIBUTARY AREA (ACRES)	4.06
EXISTING MAJOR & MINOR CONTOURS	5180
PROPOSED STORM SEWER WITH MH & INLET	
EXISTING STORM SEWER WITH MH & INLET	
STUDY AREA LIMITS	
MAJOR BASIN BOUNDARY	
MINOR BASIN BOUNDARY	
SUB-BASIN BOUNDARY	

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0 100 200 400

(IN FEET)
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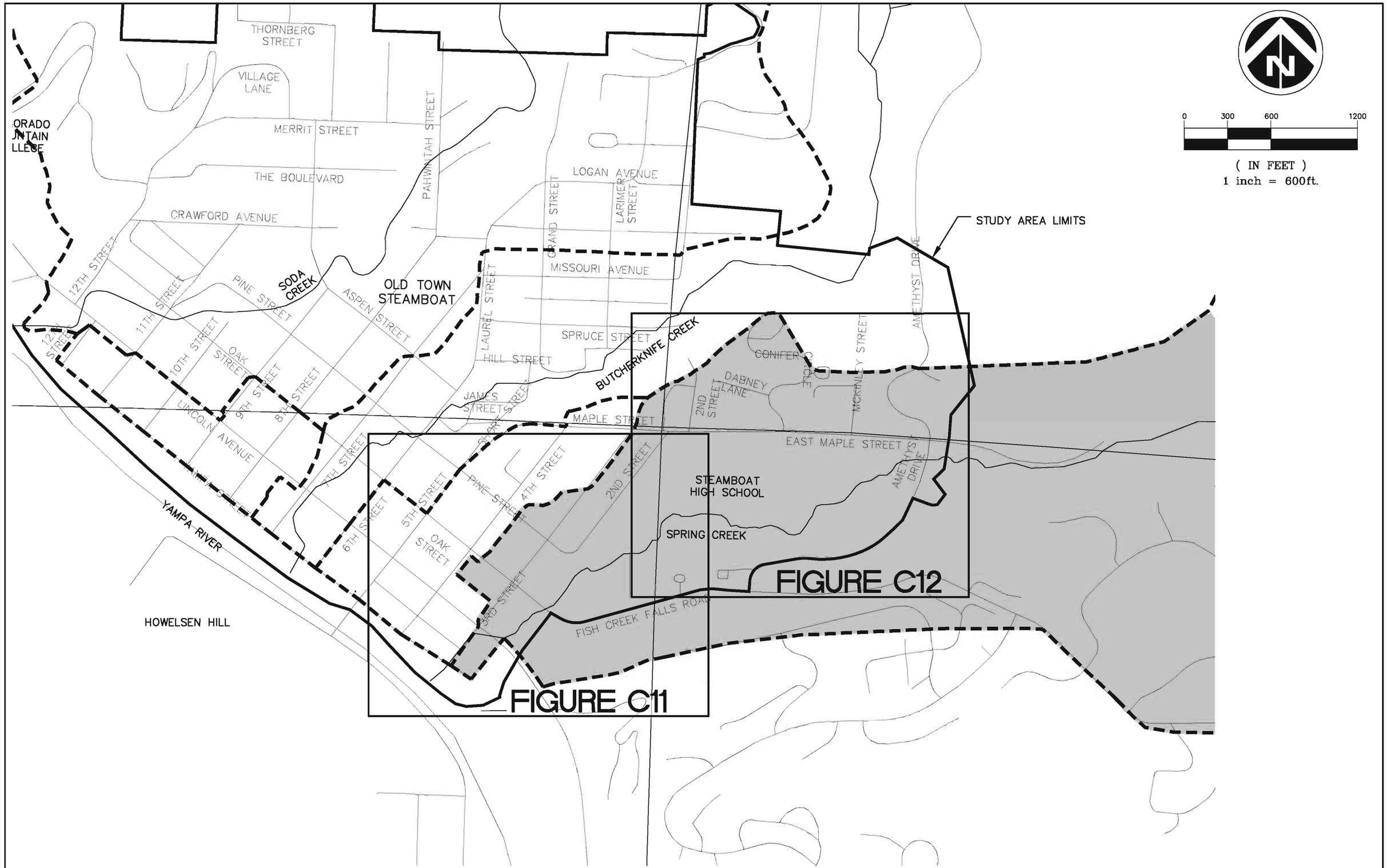
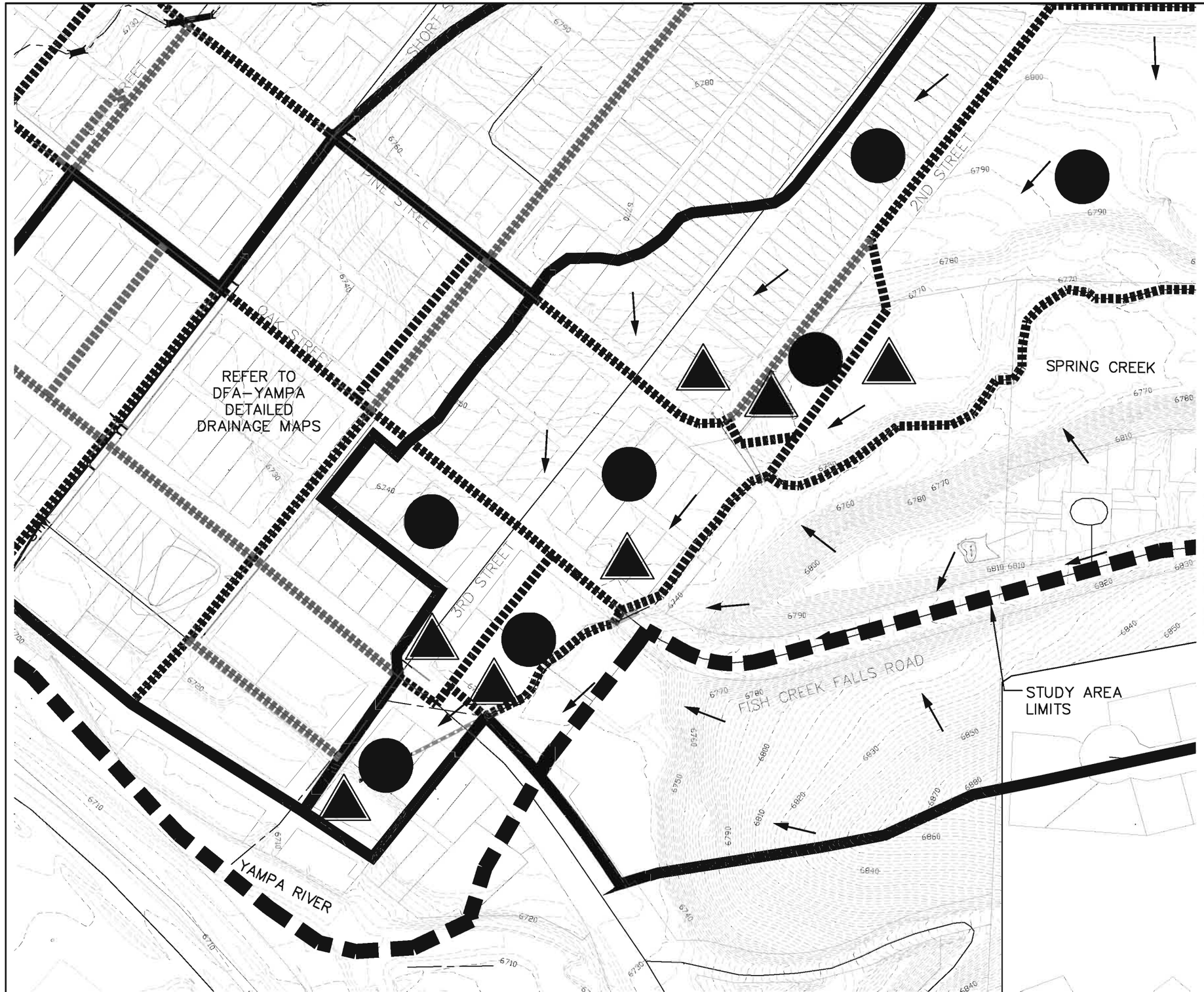
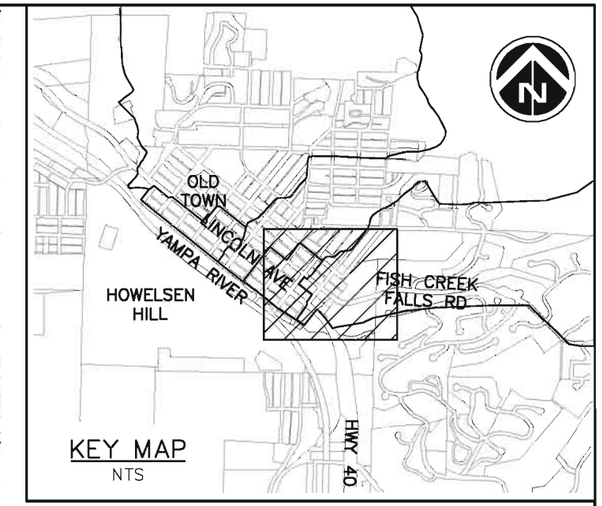


J3 Engineering Consultants Inc. 3151 S. Vaughn Way, Suite 680 Aurora, CO 80014 Tel: 303-368-5601 Fax: 303-368-5603	DESIGNED BY: JRD DATE: 11/14/08 DRAWN BY: JAN DATE: 02/28/09 CHECKED BY: KSC DATE: 04/17/09	CITY OF STEAMBOAT SPRINGS	OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS	DRAINAGE KEYMAP FOR SPRING CREEK	FIGURE C10





LEGEND

DESIGN POINT MINOR BASIN	A1 — RUNOFF COEFFICIENTS
BASIN I.D.	SO-C5
TRIBUTARY AREA (ACRES)	4.06
EXISTING MAJOR & MINOR CONTOURS	5180
PROPOSED STORM SEWER WITH MH & INLET	
EXISTING STORM SEWER WITH MH & INLET	
STUDY AREA LIMITS	
MAJOR BASIN BOUNDARY	
MINOR BASIN BOUNDARY	
SUB-BASIN BOUNDARY	

NOTES:

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2. FOR PRELIMINARY CHANNEL IMPROVEMENTS AND DESIGN INFORMATION PLEASE REFER TO THE FIGURES PROVIDED IN APPENDIX D.

0 100 200 400

(IN FEET)
1 inch = 200ft.

J3 Engineering Consultants Inc.
3151 S. Vaughn Way, Suite 680
Aurora, CO 80014
Tel: 303-368-5601 Fax: 303-368-5603

DESIGNED BY: JRD	DATE: 11/14/08	
DRAWN BY: JAN	DATE: 02/28/09	
CHECKED BY: KSC	DATE: 04/17/09	

CITY OF STEAMBOAT SPRINGS

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS

SPRING CREEK DETAILED DRAINAGE MAP

FIGURE C11

REFER TO BUTCHERKNIFE CREEK DETAILED DRAINAGE MAPS

CONIFER

DABNEY LANE

MCKINLEY STREET

AMETHYST

2ND STREET

EAST MAPLE STREET

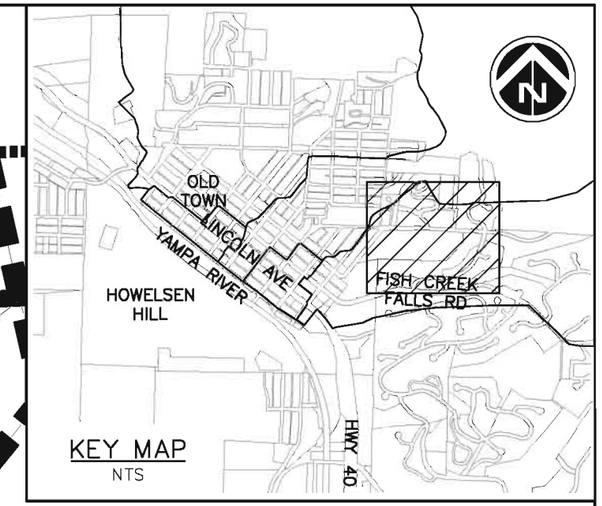
AMETHYST DRIVE

STEAMBOAT HIGH SCHOOL

SPRING CREEK

STUDY AREA LIMITS

SEE FIGURE C11



LEGEND

DESIGN POINT MINOR BASIN	A1 — RUNOFF COEFFICIENTS
BASIN I.D.	SO-C5
TRIBUTARY AREA (ACRES)	4.06
EXISTING MAJOR & MINOR CONTOURS	5180
PROPOSED STORM SEWER WITH MH & INLET	
EXISTING STORM SEWER WITH MH & INLET	
STUDY AREA LIMITS	
MAJOR BASIN BOUNDARY	
MINOR BASIN BOUNDARY	
SUB-BASIN BOUNDARY	

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(IN FEET)
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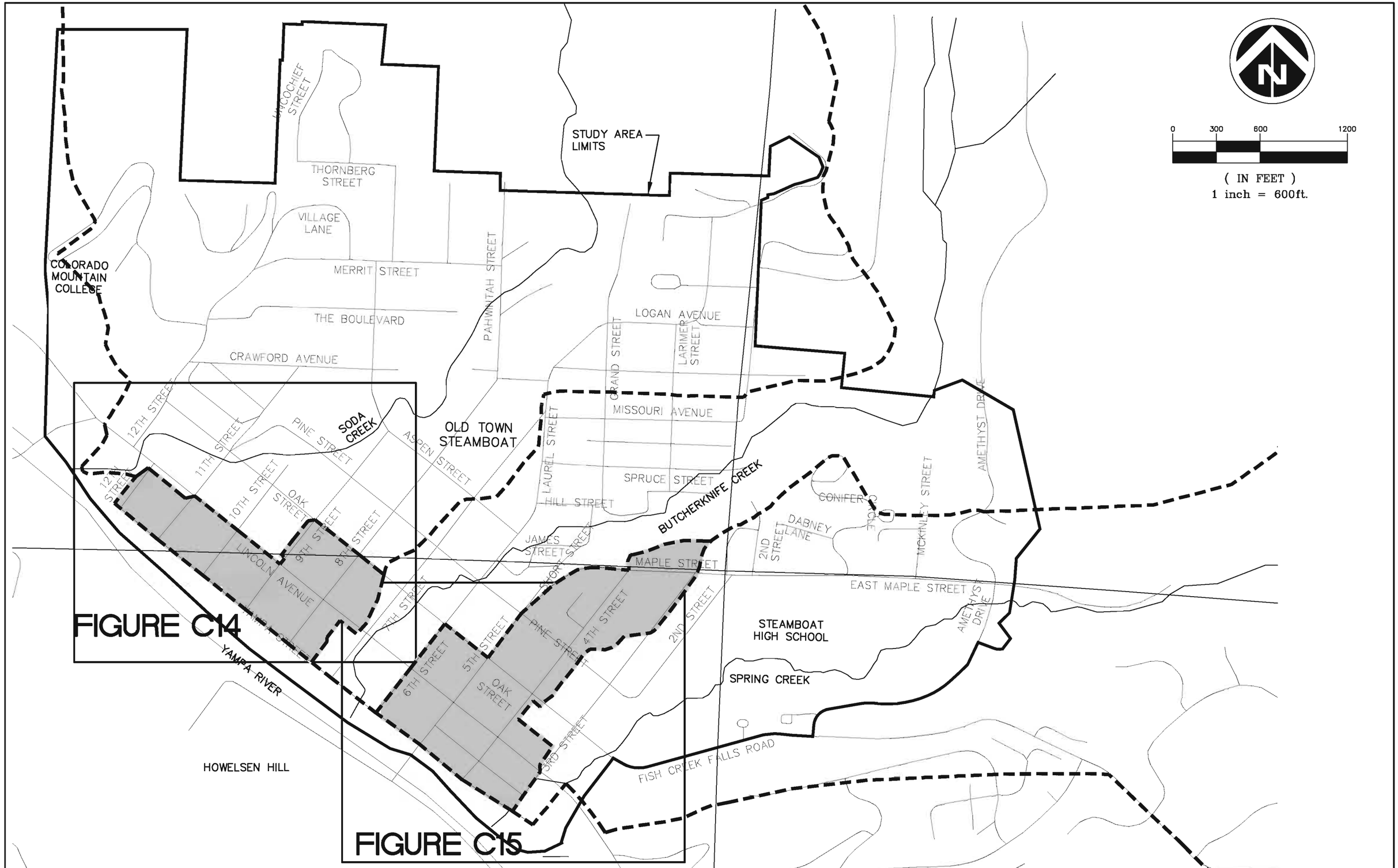


J3 Engineering Consultants Inc. 3151 S. Vaughn Way, Suite 680 Aurora, CO 80014 Tel: 303-368-5601 Fax: 303-368-5603	DESIGNED BY: JRD DATE: 11/14/08 DRAWN BY: JAN DATE: 02/28/09 CHECKED BY: KSC DATE: 04/17/09	CITY OF STEAMBOAT SPRINGS	OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS	DRAINAGE KEYMAP FOR DFA–YAMPA	FIGURE C13

REFER TO SODA CREEK DETAILED DRAINAGE MAP

SODA CREEK

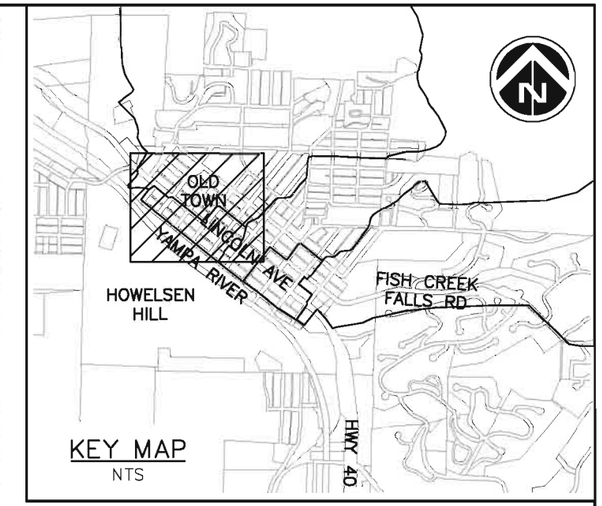
SO-STM LATERAL 2

SO-STM LATERAL 5

STUDY AREA LIMITS

YAMPA RIVER

SEE FIGURE C15



KEY MAP
NTS

LEGEND

DESIGN POINT MINOR BASIN	A1 — RUNOFF COEFFICIENTS
BASIN I.D.	SO-C5
TRIBUTARY AREA (ACRES)	4.06
EXISTING MAJOR & MINOR CONTOURS	5180
PROPOSED STORM SEWER WITH MH & INLET	
EXISTING STORM SEWER WITH MH & INLET	
STUDY AREA LIMITS	
MAJOR BASIN BOUNDARY	
MINOR BASIN BOUNDARY	
SUB-BASIN BOUNDARY	

NOTES:

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J3 Engineering Consultants Inc. 3151 S. Vaughn Way, Suite 680 Aurora, CO 80014 Tel: 303-368-5601 Fax: 303-368-5603	DESIGNED BY: JRD DRAWN BY: JAN CHECKED BY: KSC	DATE: 11/14/08 DATE: 02/28/09 DATE: 04/17/09	CITY OF STEAMBOAT SPRINGS	OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS	DFA-YAMPA DETAILED DRAINAGE MAP	FIGURE C14

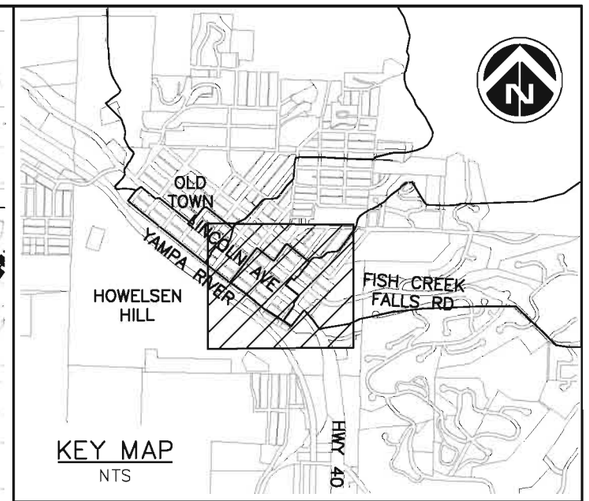
SEE FIGURE C14

SEE FIGURE C14

REFER TO BUTCHERKNIFE CREEK DETAILED DRAINAGE MAP

REFER TO SPRING CREEK DETAILED DRAINAGE MAP

JAMES STREET
SHORT STREET
MAPLE STREET
FIVE STREET
OAK STREET
2ND STREET
3RD STREET
FISH CREEK FALLS ROAD
YAMPA RIVER
STM



KEY MAP
NTS

LEGEND

DESIGN POINT MINOR BASIN	A1 — RUNOFF COEFFICIENTS
BASIN I.D.	SO-C5
TRIBUTARY AREA (ACRES)	4.06
EXISTING MAJOR & MINOR CONTOURS	5180
PROPOSED STORM SEWER WITH MH & INLET	
EXISTING STORM SEWER WITH MH & INLET	
STUDY AREA LIMITS	
MAJOR BASIN BOUNDARY	
MINOR BASIN BOUNDARY	
SUB-BASIN BOUNDARY	

NOTES:

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CITY OF STEAMBOAT SPRINGS

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS

DFA-YAMPA DETAILED DRAINAGE MAP

FIGURE C15

Old Town Drainage Study

Rational Calculations Summary ~ SODA CREEK AND PORTIONS OF DFA - YAMPA

Design Point (SO)	Tributary Drainage Basins	Tributary Area (acres)	5 -Year Runoff (cfs)	10 -Year Runoff (cfs)	25 -Year Runoff (cfs)	100 -Year Runoff (cfs)
A1	A1	9.41	5.38	8.10	11.51	18.40
A2	A2	7.41	3.73	5.93	8.74	14.45
A3	A3	4.02	2.66	3.85	5.32	8.26
A4	A4	6.48	2.83	5.35	7.70	12.47
B1	B1	40.58	14.96	27.79	44.67	79.51
B2	B2	16.31	6.68	11.59	17.97	31.08
B3	B3	7.88	5.41	7.92	11.03	17.29
B3	B1, B2 & B3	64.77	24.62	43.05	67.08	116.44
B4	B4	13.57	4.64	8.05	12.49	21.62
B4	B1, B2, B3 & B4	78.34	26.40	46.10	71.78	124.53
B5	B5	12.33	5.34	8.80	13.14	22.21
B5	B1, B2, B3, B4 & B5	90.67	29.46	50.99	78.91	136.41
B6	B6	12.33	9.61	13.87	19.05	29.58
B6	B1, B2, B3, B4, B5 & B6	103.00	35.62	59.78	90.88	154.82
B7	B7	6.17	4.17	6.03	8.32	12.93
B8	B8	2.64	2.37	3.43	4.73	7.35
B8	B1, B2, B3, B4, B5, B6, B7 & B8	111.81	38.93	64.30	96.84	163.65
B9	B9	5.32	3.55	5.14	7.10	11.02
B10	B10	2.31	1.61	2.32	3.21	4.98
B10	B1, B2, B3, B4, B5, B6, B7, B8, B9 &B10	119.44	41.47	67.74	101.34	170.24
B11	B11	7.30	4.78	6.91	9.54	14.82
B11	B1, B2, B3, B4, B5, B6, B7, B8, B9, B10 & B11	126.74	43.81	70.91	105.50	176.35
C1	C1	40.20	15.21	26.71	41.65	72.68
C2	C2	8.00	3.74	6.39	9.82	16.96
C2	C1 & C2	48.20	18.36	32.10	49.93	86.97
C3	C3	14.17	9.35	15.82	21.39	33.15
C3	C1, C2, C6 & C3	70.72	28.33	47.82	70.69	118.19
C4	C4	9.25	5.66	10.58	14.69	23.27
C5	C5	4.06	4.25	5.77	7.55	11.26
C5	C1, C2, C3, C4, C5 & C6	84.03	33.97	57.09	83.08	137.10
C7	C7	2.78	2.43	3.52	4.86	7.55
C7	C1, C2, C3, C4, C5, C6 & C7	86.81	34.44	57.54	83.57	137.64
C6	C6	8.35	5.07	7.39	10.27	16.07
D1	D1	3.57	1.58	2.92	4.19	6.78
D2	D2	4.70	3.71	5.32	7.14	11.07
D2	D1 & D2	8.27	4.58	7.21	9.95	15.69
D3	D3	2.68	1.99	3.27	4.52	7.17
D4	D4	1.99	1.84	2.66	3.68	5.72

Old Town Drainage Study

Rational Calculations Summary ~ SODA CREEK AND PORTIONS OF DFA - YAMPA

Design Point (SO)	Tributary Drainage Basins	Tributary Area (acres)	5 -Year Runoff (cfs)	10 -Year Runoff (cfs)	25 -Year Runoff (cfs)	100 -Year Runoff (cfs)
E1	E1	17.13	12.56	18.69	26.33	41.83
E2	E2	4.90	3.30	4.98	6.92	10.84
F1	F1	18.38	11.02	16.41	23.13	36.71
F2	F2	11.85	5.67	9.48	14.41	24.49
F3	F3	2.42	2.05	2.97	4.10	6.37
F3	F1 & F3	20.80	12.33	18.29	25.72	40.72
F4	F4	3.12	3.76	4.90	6.17	8.92
F5	F5	11.26	6.72	9.64	13.03	20.20
F5	F1, F2, F3, F4 , F5 & F6	52.09	26.70	39.47	55.01	87.14
F6	F6	5.06	3.29	4.71	6.34	9.82
F7	F7	5.70	3.67	5.27	7.24	11.22
F7	F1, F2, F3, F4, F5, F6 & F7	57.79	29.50	43.47	60.51	95.63
F8	F8	2.56	1.86	2.66	3.58	5.55
F8	F1, F2, F3, F4, F5, F6, F7 & F8	60.35	29.28	43.10	59.90	94.59
F9	F9	3.60	2.82	3.96	5.30	8.11
G1	G1	10.55	6.79	5.93	12.64	19.22
G2	G2	6.22	4.25	8.88	7.93	12.08
G3	G3	6.48	6.81	7.91	11.12	16.08
G4	G4	5.93	5.94	27.13	10.03	14.73
G4	G3 & G4	12.41	18.84	0.00	37.14	58.90
H1	H1	2.30	5.19	6.25	7.25	9.71
H2	H2	2.56	5.74	6.92	8.02	10.74
H2	H1 & H2	4.86	10.19	12.28	14.24	19.07
H3	H3	2.86	6.81	8.21	9.52	12.75
H3	H1 , H2, H3	7.72	15.14	18.25	21.16	28.35
H4	H4	0.40	0.95	1.15	1.33	1.78

Old Town Drainage Study

Rational Calculations Summary ~ SODA CREEK AND PORTIONS OF DFA - YAMPA

Design Point (SO)	Tributary Drainage Basins	Tributary Area (acres)	5 -Year Runoff (cfs)	10 -Year Runoff (cfs)	25 -Year Runoff (cfs)	100 -Year Runoff (cfs)
(DFA)						
Y1	Y1	2.72	6.00	7.39	8.76	11.98
Y2	Y2	0.27	0.64	0.79	0.94	1.28
Y2	Y2 & Y3	0.85	1.94	2.39	2.83	3.87
Y3	Y3	0.58	1.38	1.70	2.02	2.76
Y4	Y4	2.90	6.11	7.52	8.91	12.19
Y2	Y2, Y3 & Y4	3.75	7.90	9.52	11.04	14.78
Y5	Y5	3.39	7.72	9.51	11.27	15.41
Y6	Y6	0.12	0.29	0.35	0.42	0.57
Y6	Y6 & Y7	1.85	4.06	4.89	5.67	7.59
Y7	Y7	1.73	3.87	4.77	5.65	7.73
Y8	Y8	0.11	0.26	0.32	0.37	0.49
Y8	Y6, Y7 & Y8	1.96	3.90	4.70	5.45	7.30
Y9	Y9	1.71	3.87	4.77	5.65	7.72
Y9	Y6, Y7, Y8 & Y9	3.67	7.15	8.62	10.00	13.39
Y10	Y10	2.98	6.79	8.19	9.49	12.72
Y10	Y6, Y7, Y8, Y9 & Y10	6.65	12.09	14.57	16.90	22.63
Y11	Y11	2.62	5.63	6.78	7.86	10.53
Y12	Y12	0.33	0.79	0.95	1.10	1.47
Y12	Y11 & Y12	2.95	6.23	7.50	8.70	11.65
Y13	Y13	0.11	0.26	0.32	0.37	0.49
Y13	Y11, Y12 & Y13	3.06	6.16	7.42	8.61	11.53
Y14	Y14	0.29	0.69	0.85	1.01	1.38
Y14	Y11, Y12, Y13 & Y14	4.87	9.40	11.32	13.13	17.59
Y15	Y15	1.52	3.62	4.36	5.06	6.77

Parcel Data Table

Soda Creek and Portions of DFA - Yampa

Job No.: 50500101
Date: 2/27/2009
Calculated By: JDM
Checked By: KSC

Parcel Data Table

Area	Land Use Category	Density (DU/acre)	C5	C10	C25	C100	I (%)	Comments
Undeveloped	Undeveloped	---	0.18	0.28	0.39	0.52	5	Undeveloped Land ~ Historic Flow Analysis
Commercial (on- & off-site)	Commercial	---	0.90	0.92	0.94	0.96	100	Commercial Areas
Schools / Churches	Schools & Churches	---	0.40	0.46	0.53	0.60	50	Schools & Churches
Residential 1	Single Family Detached	---	0.35	0.42	0.50	0.58	40	Low Density
Residential 2	Single Family Detached	---	0.37	0.44	0.51	0.59	45	Medium Density
Residential 3	Single Family Detached	---	0.40	0.46	0.53	0.60	50	High Density
Open Space	Open Space, Park and Landscape Tracts	---	0.02	0.28	0.39	0.52	5	Open Space, parks and landscape tracts

*Percent Impervious values for the Residential land uses were generated off three sample blocks. Please see the attached exhibits for location and methodology.
**Runoff Coefficients are from the City of Steamboat Springs Engineering Standards, Table 5.6.1 Design Runoff Coefficients
***Percent Impervious Values for Undeveloped and Open Space have been increased to 5%
P:\Jobs\Steamboat Springs\Old Town Masterplan\MasterPlan\Drainage Calculations\2nd Submittal\[SO_Old-Town_Rational.xls]Tc

Composite Imperviousness Calculations

Soda Creek and Portions of DFA - Yampa
City of Steamboat Springs, Colorado

Job No.: 50500101
Date: 2/27/09
Calculated By: JDM
Checked By: KSC

Major Basin	Sub-Basin	Area (acres)	Parcel Imperviousness: Undeveloped 5	Commercial (on- & off-site) 100	Schools / Churches 50	Residential 1 40	Residential 2 45	Residential 3 50	Open Space 5	Composite Imperviousness (%)
Soda Creek										
A										
	A1	9.41	2.24	0.00	0.00	7.17	0.00	0.00	0.00	31.7
	A2	7.41	3.67	0.00	0.00	3.74	0.00	0.00	0.00	22.7
	A3	4.02	0.00	0.00	0.00	4.02	0.00	0.00	0.00	40.0
	A4	6.48	0.00	0.00	0.00	4.28	0.00	0.00	2.20	28.1
	Sum	**27.32**	**5.91**	**0.00**	**0.00**	**19.21**	**0.00**	**0.00**	**2.20**	29.6
B										
	B1	40.58	39.73	0.00	0.00	0.85	0.00	0.00	0.00	5.7
	B2	16.31	13.03	0.00	0.00	3.28	0.00	0.00	0.00	12.0
	B3	7.88	0.58	0.00	0.00	7.30	0.00	0.00	0.00	37.4
	B4	13.57	10.88	0.00	0.00	2.69	0.00	0.00	0.00	11.9
	B5	12.33	8.11	0.00	0.00	0.00	4.22	0.00	0.00	18.7
	B6	12.33	0.00	0.00	0.00	9.92	2.41	0.00	0.00	41.0
	B7	6.17	0.00	0.00	0.00	6.17	0.00	0.00	0.00	40.0
	B8	2.64	0.00	0.00	0.00	2.64	0.00	0.00	0.00	40.0
	B9	5.32	0.00	0.00	0.00	5.32	0.00	0.00	0.00	40.0
	B10	2.31	0.00	0.00	0.00	2.31	0.00	0.00	0.00	40.0
	B11	7.30	0.00	0.00	0.00	7.30	0.00	0.00	0.00	40.0
	Sum	**126.74**	**72.33**	**0.00**	**0.00**	**47.78**	**6.63**	**0.00**	**0.00**	20.3

Composite Imperviousness Calculations

Soda Creek and Portions of DFA - Yampa
City of Steamboat Springs, Colorado

Job No.: 50500101
Date: 2/27/09
Calculated By: JDM
Checked By: KSC

Major Basin	Sub-Basin	Area (acres)	Parcel Imperviousness: Undeveloped 5	Commercial (on- & off-site) 100	Schools / Churches 50	Residential 1 40	Residential 2 45	Residential 3 50	Open Space 5	Composite Imperviousness (%)
C										
	C1	40.20	38.40	1.70	0.10	0.00	0.00	0.00	0.00	9.1
	C2	8.00	7.49	0.51	0.00	0.00	0.00	0.00	0.00	11.1
	C3	14.17	0.00	3.17	0.00	5.24	0.00	0.00	5.76	39.2
	C4	9.25	0.00	1.25	1.43	2.22	0.00	0.00	4.35	33.2
	C5	4.06	0.00	0.86	0.00	3.20	0.00	0.00	0.00	52.7
	C6	8.35	0.48	0.00	0.00	7.87	0.00	0.00	0.00	38.0
	C7	2.78	0.00	0.00	0.00	2.78	0.00	0.00	0.00	40.0
	Sum	**86.81**	**46.37**	**7.49**	**1.53**	**21.31**	**0.00**	**0.00**	**10.11**	22.6
D										
	D1	3.57	0.00	0.00	0.00	2.43	0.00	0.00	1.14	28.8
	D2	4.70	0.00	0.00	0.00	0.00	4.70	0.00	0.00	45.0
	D3	2.68	0.00	0.00	0.00	0.00	2.14	0.00	0.54	36.9
	D4	1.99	0.00	0.00	0.00	0.00	1.99	0.00	0.00	45.0
	Sum	**12.94**	**0.00**	**0.00**	**0.00**	**2.43**	**8.83**	**0.00**	**1.68**	38.9
E										
	E1	17.13	3.79	0.00	2.72	10.62	0.00	0.00	0.00	33.8
	E2	4.90	0.00	0.00	0.00	4.58	0.00	0.00	0.32	37.7
	Sum	**22.03**	**3.79**	**0.00**	**2.72**	**15.20**	**0.00**	**0.00**	**0.32**	34.7

Composite Imperviousness Calculations

Soda Creek and Portions of DFA - Yampa
City of Steamboat Springs, Colorado

Job No.: 50500101
Date: 2/27/09
Calculated By: JDM
Checked By: KSC

Major Basin	Sub-Basin	Area (acres)	Parcel Imperviousness: Undeveloped 5	Commercial (on- & off-site) 100	Schools / Churches 50	Residential 1 40	Residential 2 45	Residential 3 50	Open Space 5	Composite Imperviousness (%)
F										
	F1	18.38	3.25	0.00	0.00	15.13	0.00	0.00	0.00	33.8
	F2	11.85	8.13	0.00	0.00	3.72	0.00	0.00	0.00	16.0
	F3	2.42	0.00	0.00	0.00	2.42	0.00	0.00	0.00	40.0
	F4	3.12	0.00	1.16	1.35	0.61	0.00	0.00	0.00	66.6
	F5	11.26	0.00	0.00	0.00	2.23	9.03	0.00	0.00	44.0
	F6	5.06	0.00	0.00	0.00	0.00	5.06	0.00	0.00	45.0
	F7	5.70	0.00	0.00	0.75	4.95	0.00	0.00	0.00	41.3
	F8	2.56	0.00	0.00	0.00	0.00	2.56	0.00	0.00	45.0
	F9	3.60	0.00	0.00	0.00	0.00	1.39	2.21	0.00	48.1
	Sum	**63.95**	**11.38**	**1.16**	**2.10**	**29.06**	**18.04**	**2.21**	**0.00**	36.9
G										
	G1	10.55	0.00	0.00	0.00	0.00	1.45	9.10	0.00	49.3
	G2	6.22	0.00	0.00	1.66	0.00	1.27	3.29	0.00	49.0
	G3	6.48	0.00	2.58	1.02	0.00	2.88	0.00	0.00	67.7
	G4	5.93	0.00	1.79	0.00	0.00	4.14	0.00	0.00	61.6
	Sum	**29.18**	**0.00**	**4.37**	**2.68**	**0.00**	**9.74**	**12.39**	**0.00**	55.8
H										
	H1	2.30	0.00	2.30	0.00	0.00	0.00	0.00	0.00	100.0
	H2	2.56	0.00	2.56	0.00	0.00	0.00	0.00	0.00	100.0
	H3	2.86	0.00	2.86	0.00	0.00	0.00	0.00	0.00	100.0
	H4	0.40	0.00	0.40	0.00	0.00	0.00	0.00	0.00	100.0
	Sum	**8.12**	**0.00**	**8.12**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	100.0

Composite Imperviousness Calculations

Soda Creek and Portions of DFA - Yampa
City of Steamboat Springs, Colorado

Job No.: 50500101
Date: 2/27/09
Calculated By: JDM
Checked By: KSC

Major Basin	Sub-Basin	Area (acres)	Parcel Imperviousness: Undeveloped 5	Commercial (on- & off-site) 100	Schools / Churches 50	Residential 1 40	Residential 2 45	Residential 3 50	Open Space 5	Composite Imperviousness (%)
Y										
	Y1	2.72	0.00	2.72	0.00	0.00	0.00	0.00	0.00	100.0
	Y2	0.27	0.00	0.27	0.00	0.00	0.00	0.00	0.00	100.0
	Y3	0.58	0.00	0.58	0.00	0.00	0.00	0.00	0.00	100.0
	Y4	2.90	0.00	2.90	0.00	0.00	0.00	0.00	0.00	100.0
	Y5	3.39	0.00	3.39	0.00	0.00	0.00	0.00	0.00	100.0
	Y6	0.12	0.00	0.12	0.00	0.00	0.00	0.00	0.00	100.0
	Y7	1.73	0.00	1.73	0.00	0.00	0.00	0.00	0.00	100.0
	Y8	0.11	0.00	0.11	0.00	0.00	0.00	0.00	0.00	100.0
	Y9	1.71	0.00	1.71	0.00	0.00	0.00	0.00	0.00	100.0
	Y10	2.98	0.00	2.98	0.00	0.00	0.00	0.00	0.00	100.0
	Y11	2.62	0.00	2.62	0.00	0.00	0.00	0.00	0.00	100.0
	Y12	0.33	0.00	0.33	0.00	0.00	0.00	0.00	0.00	100.0
	Y13	0.11	0.00	0.11	0.00	0.00	0.00	0.00	0.00	100.0
	Y14	0.29	0.00	0.29	0.00	0.00	0.00	0.00	0.00	100.0
	Y15	1.52	0.00	1.52	0.00	0.00	0.00	0.00	0.00	100.0
	Sum	**21.38**	**0.00**	**21.38**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	100.0
TOTAL	**Sum**	**398.47**	**139.78**	**42.52**	**9.03**	**134.99**	**43.24**	**14.60**	**14.31**	34.0

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Composite "C" Calculations

Soda Creek and Portions of DFA - Yampa
City of Steamboat Springs, Colorado

Job No.: 50500101
Date: 2/27/09
Calculated By: JDM
Checked By: KSC

Basin	Sub-Basin	Area (acres)	2 Year Calculation								5 Year Calculation								10 Year Calculation								25 Year Calculation								100 Year Calculation							
			Area Type								Area Type								Area Type								Area Type								Area Type							
			Undeveloped	Commercial (on- & off-site)	Schools / Churches	Residential 1	Residential 2	Residential 3	Open Space	C2	Undeveloped	Commercial (on- & off-site)	Schools / Churches	Residential 1	Residential 2	Residential 3	Open Space	C5	Undeveloped	Commercial (on- & off-site)	Schools / Churches	Residential 1	Residential 2	Residential 3	Open Space	C10	Undeveloped	Commercial (on- & off-site)	Schools / Churches	Residential 1	Residential 2	Residential 3	Open Space	C10	Undeveloped	Commercial (on- & off-site)	Schools / Churches	Residential 1	Residential 2	Residential 3	Open Space	C100
			0.08	0.89	0.34	0.28	0.31	0.34	0.08		0.18	0.90	0.40	0.35	0.37	0.40	0.02		0.28	0.92	0.46	0.42	0.44	0.46	0.28		0.39	0.94	0.53	0.50	0.51	0.53	0.39		0.52	0.96	0.60	0.58	0.59	0.60	0.52	
A																																										
	A1	9.41	2.24	0.00	0.00	7.17	0.00	0.00	0.00	0.23	2.24	0.00	0.00	7.17	0.00	0.00	0.00	0.31	2.24	0.00	0.00	7.17	0.00	0.00	0.00	0.39	2.24	0.00	0.00	7.17	0.00	0.00	0.00	0.47	2.24	0.00	0.00	7.17	0.00	0.00	0.00	0.57
	A2	7.41	3.67	0.00	0.00	3.74	0.00	0.00	0.00	0.18	3.67	0.00	0.00	3.74	0.00	0.00	0.00	0.27	3.67	0.00	0.00	3.74	0.00	0.00	0.00	0.35	3.67	0.00	0.00	3.74	0.00	0.00	0.00	0.45	3.67	0.00	0.00	3.74	0.00	0.00	0.00	0.55
	A3	4.02	0.00	0.00	0.00	4.02	0.00	0.00	0.00	0.28	0.00	0.00	0.00	4.02	0.00	0.00	0.00	0.35	0.00	0.00	0.00	4.02	0.00	0.00	0.00	0.42	0.00	0.00	0.00	4.02	0.00	0.00	0.00	0.50	0.00	0.00	0.00	4.02	0.00	0.00	0.00	0.58
	A4	6.48	0.00	0.00	0.00	4.28	0.00	0.00	2.20	0.21	0.00	0.00	0.00	4.28	0.00	0.00	2.20	0.24	0.00	0.00	0.00	4.28	0.00	0.00	2.20	0.37	0.00	0.00	0.00	4.28	0.00	0.00	2.20	0.46	0.00	0.00	0.00	4.28	0.00	0.00	2.20	0.56
B																																										
	B1	40.58	39.73	0.00	0.00	0.85	0.00	0.00	0.00	0.08	39.73	0.00	0.00	0.85	0.00	0.00	0.00	0.18	39.73	0.00	0.00	0.85	0.00	0.00	0.00	0.28	39.73	0.00	0.00	0.85	0.00	0.00	0.00	0.39	39.73	0.00	0.00	0.85	0.00	0.00	0.00	0.52
	B2	16.31	13.03	0.00	0.00	3.28	0.00	0.00	0.00	0.12	13.03	0.00	0.00	3.28	0.00	0.00	0.00	0.21	13.03	0.00	0.00	3.28	0.00	0.00	0.00	0.31	13.03	0.00	0.00	3.28	0.00	0.00	0.00	0.41	13.03	0.00	0.00	3.28	0.00	0.00	0.00	0.53
	B3	7.88	0.58	0.00	0.00	7.30	0.00	0.00	0.00	0.27	0.58	0.00	0.00	7.30	0.00	0.00	0.00	0.34	0.58	0.00	0.00	7.30	0.00	0.00	0.00	0.41	0.58	0.00	0.00	7.30	0.00	0.00	0.00	0.49	0.58	0.00	0.00	7.30	0.00	0.00	0.00	0.58
	B4	13.57	10.88	0.00	0.00	2.69	0.00	0.00	0.00	0.12	10.88	0.00	0.00	2.69	0.00	0.00	0.00	0.21	10.88	0.00	0.00	2.69	0.00	0.00	0.00	0.31	10.88	0.00	0.00	2.69	0.00	0.00	0.00	0.41	10.88	0.00	0.00	2.69	0.00	0.00	0.00	0.53
	B5	12.33	8.11	0.00	0.00	0.00	4.22	0.00	0.00	0.16	8.11	0.00	0.00	0.00	4.22	0.00	0.00	0.25	8.11	0.00	0.00	0.00	4.22	0.00	0.00	0.33	8.11	0.00	0.00	0.00	4.22	0.00	0.00	0.43	8.11	0.00	0.00	0.00	4.22	0.00	0.00	0.54
	B6	12.33	0.00	0.00	0.00	9.92	2.41	0.00	0.00	0.29	0.00	0.00	0.00	9.92	2.41	0.00	0.00	0.35	0.00	0.00	0.00	9.92	2.41	0.00	0.00	0.42	0.00	0.00	0.00	9.92	2.41	0.00	0.00	0.50	0.00	0.00	0.00	9.92	2.41	0.00	0.00	0.58
	B7	6.17	0.00	0.00	0.00	6.17	0.00	0.00	0.00	0.28	0.00	0.00	0.00	6.17	0.00	0.00	0.00	0.35	0.00	0.00	0.00	6.17	0.00	0.00	0.00	0.42	0.00	0.00	0.00	6.17	0.00	0.00	0.00	0.50	0.00	0.00	0.00	6.17	0.00	0.00	0.00	0.58
	B8	2.64	0.00	0.00	0.00	2.64	0.00	0.00	0.00	0.28	0.00	0.00	0.00	2.64	0.00	0.00	0.00	0.35	0.00	0.00	0.00	2.64	0.00	0.00	0.00	0.42	0.00	0.00	0.00	2.64	0.00	0.00	0.00	0.50	0.00	0.00	0.00	2.64	0.00	0.00	0.00	0.58
	B9	5.32	0.00	0.00	0.00	5.32	0.00	0.00	0.00	0.28	0.00	0.00	0.00	5.32	0.00	0.00	0.00	0.35	0.00	0.00	0.00	5.32	0.00	0.00	0.00	0.42	0.00	0.00	0.00	5.32	0.00	0.00	0.00	0.50	0.00	0.00	0.00	5.32	0.00	0.00	0.00	0.58
	B10	2.31	0.00	0.00	0.00	2.31	0.00	0.00	0.00	0.28	0.00	0.00	0.00	2.31	0.00	0.00	0.00	0.35	0.00	0.00	0.00	2.31	0.00	0.00	0.00	0.42	0.00	0.00	0.00	2.31	0.00	0.00	0.00	0.50	0.00	0.00	0.00	2.31	0.00	0.00	0.00	0.58
	B11	7.30	0.00	0.00	0.00	7.30	0.00	0.00	0.00	0.28	0.00	0.00	0.00	7.30	0.00	0.00	0.00	0.35	0.00	0.00	0.00	7.30	0.00	0.00	0.00	0.42	0.00	0.00	0.00	7.30	0.00	0.00	0.00	0.50	0.00	0.00	0.00	7.30	0.00	0.00	0.00	0.58
C																																										
	C1	40.20	38.40	1.70	0.10	0.00	0.00	0.00	0.00	0.11	38.40	1.70	0.10	0.00	0.00	0.00	0.00	0.21	38.40	1.70	0.10	0.00	0.00	0.00	0.00	0.31	38.40	1.70	0.10	0.00	0.00	0.00	0.00	0.41	38.40	1.70	0.10	0.00	0.00	0.00	0.00	0.54
	C2	8.00	7.49	0.51	0.00	0.00	0.00	0.00	0.00	0.13	7.49	0.51	0.00	0.00	0.00	0.00	0.00	0.23	7.49	0.51	0.00	0.00	0.00	0.00	0.00	0.32	7.49	0.51	0.00	0.00	0.00	0.00	0.00	0.43	7.49	0.51	0.00	0.00	0.00	0.00	0.00	0.55
	C3	14.17	0.00	3.17	0.00	5.24	0.00	0.00	5.76	0.34	0.00	3.17	0.00	5.24	0.00	0.00	5.76	0.34	0.00	3.17	0.00	5.24	0.00	0.00	5.76	0.47	0.00	3.17	0.00	5.24	0.00	0.00	5.76	0.55	0.00	3.17	0.00	5.24	0.00	0.00	5.76	0.64
	C4	9.25	0.00	1.25	1.43	2.22	0.00	0.00	4.35	0.28	0.00	1.25	1.43	2.22	0.00	0.00	4.35	0.28	0.00	1.25	1.43	2.22	0.00	0.00	4.35	0.43	0.00	1.25	1.43	2.22	0.00	0.00	4.35	0.51	0.00	1.25	1.43	2.22	0.00	0.00	4.35	0.61
	C5	4.06	0.00	0.86	0.00	3.20	0.00	0.00	0.00	0.41	0.00	0.86	0.00	3.20	0.00	0.00	0.00	0.47	0.00	0.86	0.00	3.20	0.00	0.00	0.00	0.53	0.00	0.86	0.00	3.20	0.00	0.00	0.00	0.59	0.00	0.86	0.00	3.20	0.00	0.00	0.00	0.66
	C7	2.78	0.00	0.00	0.00	2.78	0.00	0.00	0.00	0.28	0.00	0.00	0.00	2.78	0.00	0.00	0.00	0.35	0.00	0.00	0.00	2.78	0.00	0.00	0.00	0.42	0.00	0.00	0.00	2.78	0.00	0.00	0.00	0.50	0.00	0.00	0.00	2.78	0.00	0.00	0.00	0.58
	C6	8.35	0.48	0.00	0.00	7.87	0.00	0.00	0.00	0.27	0.48	0.00	0.00	7.87	0.00	0.00	0.00	0.34	0.48	0.00	0.00	7.87	0.00	0.00	0.00	0.41	0.48	0.00	0.00	7.87	0.00	0.00	0.00	0.49	0.48	0.00	0.00	7.87	0.00	0.00	0.00	0.58

Composite "C" Calculations

Soda Creek and Portions of DFA - Yampa
City of Steamboat Springs, Colorado

Job No.: 50500101
Date: 2/27/09
Calculated By: JDM
Checked By: KSC

Basin	Sub-Basin	Area (acres)	2 Year Calculation								5 Year Calculation								10 Year Calculation								25 Year Calculation								100 Year Calculation							
			Area Type								Area Type								Area Type								Area Type								Area Type							
			Undeveloped	Commercial (on- & off-site)	Schools / Churches	Residential 1	Residential 2	Residential 3	Open Space	C2	Undeveloped	Commercial (on- & off-site)	Schools / Churches	Residential 1	Residential 2	Residential 3	Open Space	C5	Undeveloped	Commercial (on- & off-site)	Schools / Churches	Residential 1	Residential 2	Residential 3	Open Space	C10	Undeveloped	Commercial (on- & off-site)	Schools / Churches	Residential 1	Residential 2	Residential 3	Open Space	C10	Undeveloped	Commercial (on- & off-site)	Schools / Churches	Residential 1	Residential 2	Residential 3	Open Space	C100
			0.08	0.89	0.34	0.28	0.31	0.34	0.08		0.18	0.90	0.40	0.35	0.37	0.40	0.02		0.28	0.92	0.46	0.42	0.44	0.46	0.28		0.39	0.94	0.53	0.50	0.51	0.53	0.39		0.52	0.96	0.60	0.58	0.59	0.60	0.52	
D																																										
	D1	3.57	0.00	0.00	0.00	2.43	0.00	0.00	1.14	0.22	0.00	0.00	0.00	2.43	0.00	0.00	1.14	0.24	0.00	0.00	0.00	2.43	0.00	0.00	1.14	0.38	0.00	0.00	0.00	2.43	0.00	0.00	1.14	0.46	0.00	0.00	0.00	2.43	0.00	0.00	1.14	0.56
	D2	4.70	0.00	0.00	0.00	0.00	4.70	0.00	0.00	0.31	0.00	0.00	0.00	0.00	4.70	0.00	0.00	0.37	0.00	0.00	0.00	0.00	4.70	0.00	0.00	0.44	0.00	0.00	0.00	0.00	4.70	0.00	0.00	0.51	0.00	0.00	0.00	0.00	4.70	0.00	0.00	0.59
	D3	2.68	0.00	0.00	0.00	0.00	2.14	0.00	0.54	0.26	0.00	0.00	0.00	0.00	2.14	0.00	0.54	0.30	0.00	0.00	0.00	0.00	2.14	0.00	0.54	0.41	0.00	0.00	0.00	0.00	2.14	0.00	0.54	0.49	0.00	0.00	0.00	0.00	2.14	0.00	0.54	0.58
	D4	1.99	0.00	0.00	0.00	0.00	1.99	0.00	0.00	0.31	0.00	0.00	0.00	0.00	1.99	0.00	0.00	0.37	0.00	0.00	0.00	0.00	1.99	0.00	0.00	0.44	0.00	0.00	0.00	0.00	1.99	0.00	0.00	0.51	0.00	0.00	0.00	0.00	1.99	0.00	0.00	0.59
E																																										
	E1	17.13	3.79	0.00	2.72	10.62	0.00	0.00	0.00	0.25	3.79	0.00	2.72	10.62	0.00	0.00	0.00	0.32	3.79	0.00	2.72	10.62	0.00	0.00	0.00	0.40	3.79	0.00	2.72	10.62	0.00	0.00	0.00	0.48	3.79	0.00	2.72	10.62	0.00	0.00	0.00	0.57
	E2	4.90	0.00	0.00	0.00	4.58	0.00	0.00	0.32	0.27	0.00	0.00	0.00	4.58	0.00	0.00	0.32	0.33	0.00	0.00	0.00	4.58	0.00	0.00	0.32	0.41	0.00	0.00	0.00	4.58	0.00	0.00	0.32	0.49	0.00	0.00	0.00	4.58	0.00	0.00	0.32	0.58
F																																										
	F1	18.38	3.25	0.00	0.00	15.13	0.00	0.00	0.00	0.24	3.25	0.00	0.00	15.13	0.00	0.00	0.00	0.32	3.25	0.00	0.00	15.13	0.00	0.00	0.00	0.40	3.25	0.00	0.00	15.13	0.00	0.00	0.00	0.48	3.25	0.00	0.00	15.13	0.00	0.00	0.00	0.57
	F2	11.85	8.13	0.00	0.00	3.72	0.00	0.00	0.00	0.14	8.13	0.00	0.00	3.72	0.00	0.00	0.00	0.23	8.13	0.00	0.00	3.72	0.00	0.00	0.00	0.32	8.13	0.00	0.00	3.72	0.00	0.00	0.00	0.42	8.13	0.00	0.00	3.72	0.00	0.00	0.00	0.54
	F3	2.42	0.00	0.00	0.00	2.42	0.00	0.00	0.00	0.28	0.00	0.00	0.00	2.42	0.00	0.00	0.00	0.35	0.00	0.00	0.00	2.42	0.00	0.00	0.00	0.42	0.00	0.00	0.00	2.42	0.00	0.00	0.00	0.50	0.00	0.00	0.00	2.42	0.00	0.00	0.00	0.58
	F4	3.12	0.00	1.16	1.35	0.61	0.00	0.00	0.00	0.53	0.00	1.16	1.35	0.61	0.00	0.00	0.00	0.58	0.00	1.16	1.35	0.61	0.00	0.00	0.00	0.62	0.00	1.16	1.35	0.61	0.00	0.00	0.00	0.68	0.00	1.16	1.35	0.61	0.00	0.00	0.00	0.73
	F5	11.26	0.00	0.00	0.00	2.23	9.03	0.00	0.00	0.30	0.00	0.00	0.00	2.23	9.03	0.00	0.00	0.37	0.00	0.00	0.00	2.23	9.03	0.00	0.00	0.44	0.00	0.00	0.00	2.23	9.03	0.00	0.00	0.51	0.00	0.00	0.00	2.23	9.03	0.00	0.00	0.59
	F6	5.06	0.00	0.00	0.00	0.00	5.06	0.00	0.00	0.31	0.00	0.00	0.00	0.00	5.06	0.00	0.00	0.37	0.00	0.00	0.00	0.00	5.06	0.00	0.00	0.44	0.00	0.00	0.00	0.00	5.06	0.00	0.00	0.51	0.00	0.00	0.00	0.00	5.06	0.00	0.00	0.59
	F7	5.70	0.00	0.00	0.75	4.95	0.00	0.00	0.00	0.29	0.00	0.00	0.75	4.95	0.00	0.00	0.00	0.36	0.00	0.00	0.75	4.95	0.00	0.00	0.00	0.43	0.00	0.00	0.75	4.95	0.00	0.00	0.00	0.50	0.00	0.00	0.75	4.95	0.00	0.00	0.00	0.58
	F8	2.56	0.00	0.00	0.00	0.00	2.56	0.00	0.00	0.31	0.00	0.00	0.00	0.00	2.56	0.00	0.00	0.37	0.00	0.00	0.00	0.00	2.56	0.00	0.00	0.44	0.00	0.00	0.00	0.00	2.56	0.00	0.00	0.51	0.00	0.00	0.00	0.00	2.56	0.00	0.00	0.59
	F9	3.60	0.00	0.00	0.00	0.00	1.39	2.21	0.00	0.33	0.00	0.00	0.00	0.00	1.39	2.21	0.00	0.39	0.00	0.00	0.00	0.00	1.39	2.21	0.00	0.45	0.00	0.00	0.00	0.00	1.39	2.21	0.00	0.52	0.00	0.00	0.00	0.00	1.39	2.21	0.00	0.60
G																																										
	G1	10.55	0.00	0.00	0.00	0.00	1.45	9.10	0.00	0.34	0.00	0.00	0.00	0.00	1.45	9.10	0.00	0.40	0.00	0.00	0.00	0.00	1.45	9.10	0.00	0.46	0.00	0.00	0.00	0.00	1.45	9.10	0.00	0.53	0.00	0.00	0.00	0.00	1.45	9.10	0.00	0.60
	G2	6.22	0.00	0.00	1.66	0.00	1.27	3.29	0.00	0.33	0.00	0.00	1.66	0.00	1.27	3.29	0.00	0.39	0.00	0.00	1.66	0.00	1.27	3.29	0.00	0.46	0.00	0.00	1.66	0.00	1.27	3.29	0.00	0.53	0.00	0.00	1.66	0.00	1.27	3.29	0.00	0.60
	G3	6.48	0.00	2.58	1.02	0.00	2.88	0.00	0.00	0.55	0.00	2.58	1.02	0.00	2.88	0.00	0.00	0.59	0.00	2.58	1.02	0.00	2.88	0.00	0.00	0.63	0.00	2.58	1.02	0.00	2.88	0.00	0.00	0.68	0.00	2.58	1.02	0.00	2.88	0.00	0.00	0.74
	G4	5.93	0.00	1.79	0.00	0.00	4.14	0.00	0.00	0.49	0.00	1.79	0.00	0.00	4.14	0.00	0.00	0.53	0.00	1.79	0.00	0.00	4.14	0.00	0.00	0.58	0.00	1.79	0.00	0.00	4.14	0.00	0.00	0.64	0.00	1.79	0.00	0.00	4.14	0.00	0.00	0.70

Composite "C" Calculations

Soda Creek and Portions of DFA - Yampa
City of Steamboat Springs, Colorado

Job No.: 50500101
Date: 2/27/09
Calculated By: JDM
Checked By: KSC

Basin	Sub-Basin	Area (acres)	2 Year Calculation								5 Year Calculation								10 Year Calculation								25 Year Calculation								100 Year Calculation							
			Area Type								Area Type								Area Type								Area Type								Area Type							
			Undeveloped	Commercial (on- & off-site)	Schools / Churches	Residential 1	Residential 2	Residential 3	Open Space	C2	Undeveloped	Commercial (on- & off-site)	Schools / Churches	Residential 1	Residential 2	Residential 3	Open Space	C5	Undeveloped	Commercial (on- & off-site)	Schools / Churches	Residential 1	Residential 2	Residential 3	Open Space	C10	Undeveloped	Commercial (on- & off-site)	Schools / Churches	Residential 1	Residential 2	Residential 3	Open Space	C10	Undeveloped	Commercial (on- & off-site)	Schools / Churches	Residential 1	Residential 2	Residential 3	Open Space	C100
			0.08	0.89	0.34	0.28	0.31	0.34	0.08		0.18	0.90	0.40	0.35	0.37	0.40	0.02		0.28	0.92	0.46	0.42	0.44	0.46	0.28		0.39	0.94	0.53	0.50	0.51	0.53	0.39		0.52	0.96	0.60	0.58	0.59	0.60	0.52	
H																																										
	H1	2.30	0.00	2.30	0.00	0.00	0.00	0.00	0.00	0.89	0.00	2.30	0.00	0.00	0.00	0.00	0.00	0.90	0.00	2.30	0.00	0.00	0.00	0.00	0.00	0.92	0.00	2.30	0.00	0.00	0.00	0.00	0.00	0.94	0.00	2.30	0.00	0.00	0.00	0.00	0.00	0.96
	H2	2.56	0.00	2.56	0.00	0.00	0.00	0.00	0.00	0.89	0.00	2.56	0.00	0.00	0.00	0.00	0.00	0.90	0.00	2.56	0.00	0.00	0.00	0.00	0.00	0.92	0.00	2.56	0.00	0.00	0.00	0.00	0.00	0.94	0.00	2.56	0.00	0.00	0.00	0.00	0.00	0.96
	H3	2.86	0.00	2.86	0.00	0.00	0.00	0.00	0.00	0.89	0.00	2.86	0.00	0.00	0.00	0.00	0.00	0.90	0.00	2.86	0.00	0.00	0.00	0.00	0.00	0.92	0.00	2.86	0.00	0.00	0.00	0.00	0.00	0.94	0.00	2.86	0.00	0.00	0.00	0.00	0.00	0.96
	H4	0.40	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.89	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.90	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.92	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.94	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.96
Y																																										
	Y1	2.72	0.00	2.72	0.00	0.00	0.00	0.00	0.00	0.89	0.00	2.72	0.00	0.00	0.00	0.00	0.00	0.90	0.00	2.72	0.00	0.00	0.00	0.00	0.00	0.92	0.00	2.72	0.00	0.00	0.00	0.00	0.00	0.94	0.00	2.72	0.00	0.00	0.00	0.00	0.00	0.96
	Y2	0.27	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.89	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.90	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.92	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.94	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.96
	Y3	0.58	0.00	0.58	0.00	0.00	0.00	0.00	0.00	0.89	0.00	0.58	0.00	0.00	0.00	0.00	0.00	0.90	0.00	0.58	0.00	0.00	0.00	0.00	0.00	0.92	0.00	0.58	0.00	0.00	0.00	0.00	0.00	0.94	0.00	0.58	0.00	0.00	0.00	0.00	0.00	0.96
	Y4	2.90	0.00	2.90	0.00	0.00	0.00	0.00	0.00	0.89	0.00	2.90	0.00	0.00	0.00	0.00	0.00	0.90	0.00	2.90	0.00	0.00	0.00	0.00	0.00	0.92	0.00	2.90	0.00	0.00	0.00	0.00	0.00	0.94	0.00	2.90	0.00	0.00	0.00	0.00	0.00	0.96
	Y5	3.39	0.00	3.39	0.00	0.00	0.00	0.00	0.00	0.89	0.00	3.39	0.00	0.00	0.00	0.00	0.00	0.90	0.00	3.39	0.00	0.00	0.00	0.00	0.00	0.92	0.00	3.39	0.00	0.00	0.00	0.00	0.00	0.94	0.00	3.39	0.00	0.00	0.00	0.00	0.00	0.96
	Y6	0.12	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.89	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.90	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.92	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.94	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.96
	Y7	1.73	0.00	1.73	0.00	0.00	0.00	0.00	0.00	0.89	0.00	1.73	0.00	0.00	0.00	0.00	0.00	0.90	0.00	1.73	0.00	0.00	0.00	0.00	0.00	0.92	0.00	1.73	0.00	0.00	0.00	0.00	0.00	0.94	0.00	1.73	0.00	0.00	0.00	0.00	0.00	0.96
	Y8	0.11	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.89	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.90	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.92	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.94	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.96
	Y9	1.71	0.00	1.71	0.00	0.00	0.00	0.00	0.00	0.89	0.00	1.71	0.00	0.00	0.00	0.00	0.00	0.90	0.00	1.71	0.00	0.00	0.00	0.00	0.00	0.92	0.00	1.71	0.00	0.00	0.00	0.00	0.00	0.94	0.00	1.71	0.00	0.00	0.00	0.00	0.00	0.96
	Y10	2.98	0.00	2.98	0.00	0.00	0.00	0.00	0.00	0.89	0.00	2.98	0.00	0.00	0.00	0.00	0.00	0.90	0.00	2.98	0.00	0.00	0.00	0.00	0.00	0.92	0.00	2.98	0.00	0.00	0.00	0.00	0.00	0.94	0.00	2.98	0.00	0.00	0.00	0.00	0.00	0.96
	Y11	2.62	0.00	2.62	0.00	0.00	0.00	0.00	0.00	0.89	0.00	2.62	0.00	0.00	0.00	0.00	0.00	0.90	0.00	2.62	0.00	0.00	0.00	0.00	0.00	0.92	0.00	2.62	0.00	0.00	0.00	0.00	0.00	0.94	0.00	2.62	0.00	0.00	0.00	0.00	0.00	0.96
	Y12	0.33	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.89	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.90	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.92	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.94	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.96
	Y13	0.11	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.89	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.90	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.92	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.94	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.96
	Y14	0.29	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.89	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.90	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.92	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.94	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.96
	Y15	1.52	0.00	1.52	0.00	0.00	0.00	0.00	0.00	0.89	0.00	1.52	0.00	0.00	0.00	0.00	0.00	0.90	0.00	1.52	0.00	0.00	0.00	0.00	0.00	0.92	0.00	1.52	0.00	0.00	0.00	0.00	0.00	0.94	0.00	1.52	0.00	0.00	0.00	0.00	0.00	0.96

TIME OF CONCENTRATION

Soda Creek and Portions of DFA - Yampa

2/27/2009

Job No.: 50500101
Date: 2/27/09
Calculated By: JDM
Checked By: KSC

BASIN	SUB-BASIN DATA			INITIAL/OVERLAND TIME (Tc)			TRAVEL TIME (Tt)						Rational Tc	Tc Check for Urban Catchments		FINAL Tc	CONVEYANCE REMARKS
	DESIG:	AREA (acres)	C5	LENGTH (ft)	SLOPE (ft/ft)	Ti (min)	LENGTH (ft)	AVG. SLOPE DY	(%)	Conv. Type*	VEL (fps)	Tt (min)	COMP Tc (min)	TOTAL LENGTH (ft)	Tc=(L/180)+10 (min)	(min)	
A	A1	9.41	0.31	300	0.220	8.9	1220	98.0	8.0	5	4.3	4.8	13.7	1520	18.4	**13.7**	Grass Swale
	A2	7.41	0.27	300	0.260	8.9	708	76.0	10.7	5	4.9	2.4	11.3	1008	15.6	**11.3**	Grass Swale
	A3	4.02	0.35	242	0.050	12.4	290	9.0	3.1	5	2.6	1.8	14.2	532	13.0	**13.0**	Grass Swale
	A4	6.48	0.24	285	0.028	18.7	320	31.0	9.7	3	2.2	2.4	21.2	605	13.4	**13.4**	Pasture
B	B1	40.58	0.18	300	0.300	9.3	1323	140.0	10.6	5	4.9	4.5	13.8	1623	19.0	**13.8**	Grass Swale
	B2	16.31	0.21	300	0.260	9.5	1029	131.0	12.7	5	5.4	3.2	12.7	1329	17.4	**12.7**	Grass Swale
	B3	7.88	0.34	255	0.280	7.3	904	70.0	7.7	5	4.2	3.6	10.9	1159	16.4	**10.9**	Grass Swale
	B4	13.57	0.21	300	0.083	13.8	1446	172.0	11.9	5	5.2	4.7	18.4	1746	19.7	**18.4**	Grass Swale
	B5	12.33	0.25	256	0.129	10.6	1240	121.0	9.8	5	4.7	4.4	15.0	1496	18.3	**15.0**	Grass Swale
	B6	12.33	0.35	100	0.120	5.9	720	51.0	7.1	5	4.0	3.0	8.9	820	14.6	**8.9**	Grass Swale
	B7	6.17	0.35	203	0.108	8.8	681	30.0	4.4	5	3.1	3.6	12.4	884	14.9	**12.4**	Grass Swale
	B8	2.64	0.35	151	0.395	4.9	246	43.0	17.5	5	6.3	0.7	5.6	397	12.2	**5.6**	Grass Swale
	B9	5.32	0.35	90	0.040	8.1	782	28.0	3.6	5	2.8	4.6	12.7	872	14.8	**12.7**	Grass Swale
	B10	2.31	0.35	80	0.040	7.7	584	16.0	2.7	5	2.5	3.9	11.6	664	13.7	**11.6**	Grass Swale
	B11	7.30	0.35	107	0.033	9.4	491	40.0	8.1	3	2.0	4.1	13.5	598	13.3	**13.3**	Pasture

TIME OF CONCENTRATION

Soda Creek and Portions of DFA - Yampa

2/27/2009

Job No.: 50500101
Date: 2/27/09
Calculated By: JDM
Checked By: KSC

BASIN	SUB-BASIN DATA			INITIAL/OVERLAND TIME (Tc)			TRAVEL TIME (Tt)						Rational Tc	Tc Check for Urban Catchments		FINAL Tc	CONVEYANCE REMARKS
	DESIG:	AREA (acres)	C5	LENGTH (ft)	SLOPE (ft/ft)	Ti (min)	LENGTH (ft)	AVG. SLOPE DY	AVG. SLOPE (%)	Conv. Type*	VEL (fps)	Tt (min)	COMP Tc (min)	TOTAL LENGTH (ft)	Tc=(L/180)+10 (min)	(min)	
C	C1	40.20	0.21	300	0.330	8.8	2188	379.0	17.3	5	6.2	5.8	14.6	2488	23.8	**14.6**	Grass Swale
	C2	8.00	0.23	193	0.254	7.5	1036	153.0	14.8	5	5.8	3.0	10.5	1229	16.8	**10.5**	Grass Swale
	C3	14.17	0.34	259	0.386	6.6	1352	102.0	7.5	5	4.1	5.5	12.1	1611	19.0	**12.1**	Grass Swale
	C4	9.25	0.28	44	0.409	2.9	1538	130.0	8.5	5	4.4	5.9	8.8	1582	18.8	**8.8**	Grass Swale
	C5	4.06	0.47	111	0.234	4.3	822	38.0	4.6	5	3.2	4.2	8.5	933	15.2	**8.5**	Grass Swale
	C6	8.35	0.34	185	0.250	6.4	1978	138.0	7.0	5	4.0	8.3	14.8	2163	22.0	**14.8**	Grass Swale
	C7	2.78	0.35	119	0.303	4.8	315	22.0	7.0	5	4.0	1.3	6.1	434	12.4	**6.1**	Grass Swale
D	D1	3.57	0.24	300	0.040	16.9	480	38.0	7.9	5	4.2	1.9	18.8	780	14.3	**14.3**	Grass Swale
	D2	4.70	0.37	50	0.020	7.4	728	50.0	6.9	6	5.2	2.3	9.7	778	14.3	**9.7**	Paved Gutter
	D3	2.68	0.30	106	0.260	5.1	423	38.0	9.0	6	6.0	1.2	6.3	529	12.9	**6.3**	Paved Gutter
	D4	1.99	0.37	50	0.120	4.1	135	22.0	16.3	6	8.1	0.3	4.4	185	11.0	**5.0**	Paved Gutter
E	E1	17.13	0.32	101	0.277	4.7	940	94.0	10.0	5	4.7	3.3	8.0	1041	15.8	**8.0**	Grass Swale
	E2	4.90	0.33	56	0.020	8.3	363	10.0	2.8	5	2.5	2.4	10.7	419	12.3	**10.7**	Grass Swale

TIME OF CONCENTRATION

Soda Creek and Portions of DFA - Yampa

2/27/2009

Job No.: 50500101
Date: 2/27/09
Calculated By: JDM
Checked By: KSC

BASIN	SUB-BASIN DATA			INITIAL/OVERLAND TIME (Tc)			TRAVEL TIME (Tt)						Rational Tc	Tc Check for Urban Catchments		FINAL Tc	CONVEYANCE REMARKS
	DESIG:	AREA (acres)	C5	LENGTH (ft)	SLOPE (ft/ft)	Ti (min)	LENGTH (ft)	AVG. SLOPE DY	(%)	Conv. Type*	VEL (fps)	Tt (min)	COMP Tc (min)	TOTAL LENGTH (ft)	Tc=(L/180)+10 (min)	(min)	
F	F1	18.38	0.32	216	0.100	9.7	1012	100.0	9.9	5	4.7	3.6	13.3	1228	16.8	**13.3**	Grass Swale
	F2	11.85	0.23	165	0.150	8.2	762	85.0	11.2	5	5.0	2.5	10.8	927	15.2	**10.8**	Grass Swale
	F3	2.42	0.35	20	0.030	4.2	540	30.0	5.6	5	3.5	2.5	6.8	560	13.1	**6.8**	Grass Swale
	F4	3.12	0.58	106	0.085	4.8	753	18.0	2.4	5	2.3	5.4	10.2	859	14.8	**10.2**	Grass Swale
	F5	11.26	0.37	120	0.025	10.7	1282	24.0	1.9	6	2.7	7.8	18.5	1402	17.8	**17.8**	Paved Gutter
	F6	5.06	0.37	56	0.020	7.8	1202	22.0	1.8	6	2.7	7.4	15.3	1258	17.0	**15.3**	Paved Gutter
	F7	5.70	0.36	250	0.104	9.8	543	6.0	1.1	5	1.6	5.7	15.5	793	14.4	**14.4**	Grass Swale
	F8	2.56	0.37	100	0.020	10.5	250	6.0	2.4	5	2.3	1.8	12.3	350	11.9	**11.9**	Grass Swale
	F9	3.60	0.39	101	0.051	7.5	240	6.0	2.5	3	1.1	3.6	11.2	341	11.9	**11.2**	Pasture
G	G1	10.55	0.40	71	0.020	8.5	1382	21.0	1.5	6	2.5	9.3	17.9	1453	18.1	**17.9**	Paved Gutter
	G2	6.22	0.39	103	0.020	10.3	913	17.0	1.9	6	2.7	5.6	15.9	1016	15.6	**15.6**	Paved Gutter
	G3	6.48	0.59	126	0.024	7.8	872	10.0	1.1	6	2.1	6.8	14.6	998	15.5	**14.6**	Paved Gutter
	G4	5.93	0.53	116	0.015	9.7	520	9.0	1.7	6	2.6	3.3	13.0	636	13.5	**13.0**	Paved Gutter
H	H1	2.30	0.90	98	0.015	3.1	422	6.0	1.4	6	2.4	2.9	6.1	520	12.9	**6.1**	Paved Gutter
	H2	2.56	0.90	105	0.010	3.7	355	5.0	1.4	6	2.4	2.5	6.2	460	12.6	**6.2**	Paved Gutter
	H3	2.86	0.90	30	0.010	2.0	472	8.0	1.7	6	2.6	3.0	5.0	502	12.8	**5.0**	Paved Gutter
	H4	0.40	0.90	60	0.015	2.4	201	2.0	1.0	6	2.0	1.7	4.1	261	11.5	**5.0**	Paved Gutter

TIME OF CONCENTRATION

Soda Creek and Portions of DFA - Yampa

2/27/2009

Job No.: 50500101
Date: 2/27/09
Calculated By: JDM
Checked By: KSC

BASIN	SUB-BASIN DATA			INITIAL/OVERLAND TIME (Tc)			TRAVEL TIME (Tt)						Rational Tc	Tc Check for Urban Catchments		FINAL Tc	CONVEYANCE REMARKS
	DESIG:	AREA (acres)	C5	LENGTH (ft)	SLOPE (ft/ft)	Ti (min)	LENGTH (ft)	AVG. SLOPE DY	(%)	Conv. Type*	VEL (fps)	Tt (min)	COMP Tc (min)	TOTAL LENGTH (ft)	Tc=(L/180)+10 (min)	(min)	
Y	Y1	2.72	0.90	78	0.010	3.2	459	6.0	1.3	6	2.3	3.3	6.5	537	13.0	**6.5**	Paved Gutter
	Y2	0.27	0.90	20	0.010	1.6	257	6.0	2.3	6	3.1	1.4	3.0	277	11.5	**5.0**	Paved Gutter
	Y3	0.58	0.90	55	0.010	2.7	425	12.0	2.8	6	3.4	2.1	4.8	480	12.7	**5.0**	Paved Gutter
	Y4	2.90	0.90	40	0.010	2.3	620	6.0	1.0	6	2.0	5.3	7.5	660	13.7	**7.5**	Paved Gutter
	Y5	3.39	0.90	55	0.010	2.7	605	15.0	2.5	6	3.1	3.2	5.9	660	13.7	**5.9**	Paved Gutter
	Y6	0.12	0.90	10	0.010	1.1	160	2.0	1.3	6	2.2	1.2	2.3	170	10.9	**5.0**	Paved Gutter
	Y7	1.73	0.90	81	0.010	3.2	426	6.0	1.4	6	2.4	3.0	6.2	507	12.8	**6.2**	Paved Gutter
	Y8	0.11	0.90	10	0.010	1.1	160	2.0	1.3	6	2.2	1.2	2.3	170	10.9	**5.0**	Paved Gutter
	Y9	1.71	0.90	40	0.010	2.3	464	5.0	1.1	6	2.1	3.7	6.0	504	12.8	**6.0**	Paved Gutter
	Y10	2.98	0.90	55	0.010	2.7	615	16.0	2.6	6	3.2	3.2	5.9	670	13.7	**5.9**	Paved Gutter
	Y11	2.62	0.90	79	0.010	3.2	478	5.0	1.0	6	2.0	3.9	7.1	557	13.1	**7.1**	Paved Gutter
	Y12	0.33	0.90	40	0.010	2.3	278	4.0	1.4	6	2.4	1.9	4.2	318	11.8	**5.0**	Paved Gutter
	Y13	0.11	0.90	30	0.010	2.0	140	4.0	2.9	6	3.4	0.7	2.7	170	10.9	**5.0**	Paved Gutter
	Y14	0.29	0.90	30	0.010	2.0	210	11.0	5.2	6	4.6	0.8	2.7	240	11.3	**5.0**	Paved Gutter
	Y15	1.52	0.90	55	0.010	2.7	285	12.0	4.2	6	4.1	1.2	3.8	340	11.9	**5.0**	Paved Gutter

** Note: Conveyance Coefficients - Type 1-Heavy Meadow, Type 2-Tillage/field, Type 3-Short Pasture & Lawn, Type 4-Nearly Bare Ground, Type 5-Grassed Waterway, Type 6-Paved Areas & Shallow Paved Swales.*

J3 Engineering Consultants, Inc.

P:\Jobs\Steamboat Springs\Old Town Masterplan\MasterPlan\Drainage Calculations\2nd Submittal\[SO_Old-Town_Rational.xls]Tc

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	**0.78**			DESIGN STORM:	**5-YEAR (minor storm)**
10-year P1 =	0.94	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	1.09	CHECKED BY: KSC	MAJOR BASIN: Soda Creek and Portions of DFA - Yampa	LOCATION:	City of Steamboat Springs, Colorado
100-year P1 =	1.46				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Sub-basin A																					
A1	A1		9.41	0.31	13.7	2.91	1.85	5.38													Direct runoff to DP A1 & Soda Creek
A2	A2		7.41	0.27	13.0	1.97	1.89	3.73													Direct Runoff to DP A2 & Soda Creek
A3	A3		4.02	0.35	13.0	1.41	1.89	2.66													Direct Runoff to DP A3 & Soda Creek
A4	A4		6.48	0.24	13.8	1.54	1.84	2.83													Direct Runoff to DP A4 & Soda Creek
Sub-basin B																					
B1	B1		40.58	0.18	11.3	7.45	2.01	14.96					7.7	14.96				1001.0	5.5	3.0	Direct runoff to DP B1 Ditch flow to DP B3
B2	B2		16.31	0.21	12.7	3.49	1.91	6.68					6.0	6.68				398.0	4.9	1.4	Direct runoff to DP B2 Ditch flow to DP B3
B3	B3		7.88	0.34	10.9	2.66	2.04	5.41													Direct runoff to DP B3
	B3	B1, B2 & B3	64.77	0.21					14.3	13.60	1.81	24.62	3.9	24.62				285.0	3.9	1.2	Combine flow at DP B3 Ditch Flow to DP B4
B4	B4		13.57	0.21	18.4	2.90	1.60	4.64													Direct Runoff to DP B4
	B4	B1, B2, B3 & B4	78.34	0.21					18.4	16.50	1.60	26.40	5.9	26.40				640.0	4.9	2.2	Combine flow at DP B4 Ditch Flow to DP B7
B5	B5		12.33	0.25	15.0	3.02	1.77	5.34													Direct Runoff to DP B5
	B5	B1, B2, B3, B4 & B5	90.67	0.22					20.6	19.52	1.51	29.46	4.4	29.46				118.0	4.2	0.5	Combine flow at DP B5 Ditch Flow to DP B6
B6	B6		12.33	0.35	8.9	4.36	2.20	9.61													Direct runoff to DP B6
	B6	B1, B2, B3, B4, B5 & B6	103.00	0.23					21.1	23.89	1.49	35.62	4.4	35.62				332.0	4.2	1.3	Combine flow at DP B6 Ditch Flow to DP B8
B7	B7		6.17	0.35	12.4	2.16	1.93	4.17													Direct runoff to DP B7 Ditch Flow to DP B10
B8	B8		2.64	0.35	5.6	0.92	2.57	2.37													Direct runoff to DP B8
	B8	B1, B2, B3, B4, B5, B6, B7 & B8	111.81	0.24					22.4	26.97	1.44	38.93	6.9	38.93				412.0	5.3	1.3	Combine flow at DP B8 Ditch Flow to DP B10
B9	B9		5.32	0.35	12.7	1.86	1.91	3.55													Direct runoff to DP B9
B10	B10		2.31	0.35	11.6	0.81	1.99	1.61													Direct runoff to DP B10
	B10	B1, B2, B3, B4, B5, B6, B7, B8, B9 &B10	119.44	0.25					23.7	29.64	1.40	41.47	6.1	41.47				360.0	4.9	1.2	Combine flow at DP B10 Ditch Flow to DP B11
B11	B11		7.30	0.35	13.3	2.56	1.87	4.78													Direct runoff to DP B11
	B11	B1, B2, B3, B4, B5, B6, B7, B8, B9, B10 & B11	126.74	0.25					24.9	32.20	1.36	43.81									Combine flow at DP B11

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	**0.78**			DESIGN STORM:	**5-YEAR (minor storm)**
10-year P1 =	0.94	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	1.09	CHECKED BY: KSC	MAJOR BASIN: Soda Creek and Portions of DFA - Yampa	LOCATION:	City of Steamboat Springs, Colorado
100-year P1 =	1.46				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Sub-basin C																					
C1	C1		40.20	0.21	14.6	8.48	1.79	15.21					7.5	15.21				50.0	5.5	0.2	Direct runoff to DP C1 Ditch flow to DP C2
C2	C2		8.00	0.23	10.5	1.81	2.07	3.74													Direct runoff to DP C2
	C2	C1 & C2	48.20	0.21					14.8	10.29	1.78	18.36	7.5	18.36				1352.0	5.5	4.1	Combine flow at DP C2 Ditch flow to DP C3
C3	C3		14.17	0.34	12.1	4.79	1.95	9.35													Direct runoff to DP C3
	C3	C1, C2, C6 & C3	70.72	0.25					18.9	17.92	1.58	28.33	5.6	28.33				430.0	4.7	1.5	Combine flow at DP C3 Ditch flow to DP C4
C4	C4		9.25	0.28	8.8	2.55	2.22	5.66													Direct runoff to DP C4
C5	C5		4.06	0.47	8.5	1.89	2.24	4.25													Direct runoff to DP C5
	C5	C1, C2, C3, C4, C5 & C6	84.03	0.27					20.4	22.37	1.52	33.97	7.1	33.97				365.0	5.3	1.1	Combine flow at DP C5 Ditch flow to DP C7
C7	C7		2.78	0.35	6.1	0.97	2.50	2.43													Direct runoff to DP C7
	C7	C1, C2, C3, C4, C5, C6 & C7	86.81	0.27					21.5	23.34	1.48	34.44									Combine flow at DP C7 Pipe outfall to Soda Creek
C6	C6		8.35	0.34	14.8	2.84	1.78	5.07					8.0	5.07				30.0	5.7	0.1	Direct runoff at DP C6
Sub-basin D																					
D1	D1		3.57	0.24	14.3	0.87	1.81	1.58					9.3	1.6				343.0	6.1	0.9	Direct runoff at DP D1 Ditch flow to DP D2
D2	D2		4.70	0.37	9.7	1.74	2.13	3.71													Direct runoff at DP D2
	D2	D1 & D2	8.27	0.32					15.3	2.61	1.76	4.58									Combine flow at DP D2 Outfall to Soda Creek
D3	D3		2.68	0.30	6.3	0.80	2.48	1.99													Direct runoff at DP D3 Outfall to Soda Creek
D4	D4		1.99	0.35	5.0	0.70	2.65	1.84													Direct runoff at DP D4
Sub-basin E																					
E1	E1		17.13	0.32	8.0	5.49	2.29	12.56													Direct runoff at DP E1 Direct Discharge to Soda Creek
E2	E2		4.90	0.33	10.7	1.61	2.05	3.30													Direct runoff at DP E2

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

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10-year P1 =	0.94	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	1.09	CHECKED BY: KSC	MAJOR BASIN: Soda Creek and Portions of DFA - Yampa	LOCATION:	City of Steamboat Springs, Colorado
100-year P1 =	1.46				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Sub-basin F																					
F1	F1		18.38	0.32	13.3	5.88	1.87	11.02					9.6	11.02				249.0	6.2	0.7	Direct runoff at DP F1 Pipe flow to DP F3
F2	F2		11.85	0.23	10.8	2.77	2.05	5.67					2.0	5.67				1380.0	2.8	8.1	Direct runoff at DP F2 Ditch flow to DP F5
F3	F3		2.42	0.35	6.8	0.85	2.42	2.05													Direct runoff at DP F3
	F3	F1 & F3	20.80	0.32					13.9	6.73	1.83	12.33	2.4	12.33				1081.0	3.1	5.8	Combine flow at DP F3 Pipe flow to DP F5
F4	F4		3.12	0.58	10.2	1.80	2.09	3.76					3.4	3.76				485.0	3.7	2.2	Direct runoff at DP F4 Pipe flow to DP F5
F5	F5		11.26	0.37	17.8	4.12	1.63	6.72													Direct runoff at DP F5
	F5	F1, F2, F3, F4 , F5 & F6	52.09	0.33					19.7	17.28	1.54	26.70	1.0	26.70				53.0	2.0	0.4	Combine flow at DP F5 Pipe flow to DP F7
F6	F6		5.06	0.37	15.3	1.87	1.76	3.29													Direct runoff at DP F6
F7	F7		5.70	0.36	14.4	2.03	1.80	3.67													Direct runoff at DP F7
	F7	F1, F2, F3, F4, F5, F6 & F7	57.79	0.33					20.2	19.32	1.53	29.50	1.7	29.50				343.0	2.6	2.2	Combine flow at DP F7 Ditch flow to DP F8
F8	F8		2.56	0.37	11.9	0.95	1.96	1.86													Direct runoff at DP F8
	F8	F1, F2, F3, F4, F5, F6, F7 & F8	60.35	0.34					22.4	20.26	1.45	29.28									Combine flow at DP F8 Direct Discharge to Soda Creek
F9	F9		3.60	0.39	11.2	1.40	2.02	2.82													Direct runoff at DP F9
Sub-basin G																					
G1	G1		10.55	0.40	17.9	4.18	1.63	6.79													Direct runoff at DP G1 Direct Discharge to Soda Creek
G2	G2		6.22	0.39	15.6	2.45	1.74	4.25													Direct runoff at DP G2 Direct Discharge to Soda Creek
G3	G3		6.48	0.59	14.6	3.80	1.79	6.81					1.5	6.81				635.0	2.4	4.3	Direct runoff to DP G3 Curb flow to DP G4
G4	G4		5.93	0.53	13.0	3.14	1.89	5.94													Direct runoff to DP G4
	G4	G3 & G4	12.41	0.96					18.9	11.93	1.58	18.84									Combine flow at DP G4

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

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25-year P1 =	1.09	CHECKED BY: KSC	MAJOR BASIN: Soda Creek and Portions of DFA - Yampa	LOCATION:	City of Steamboat Springs, Colorado
100-year P1 =	1.46				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Sub-basin H																					
H1	H1		2.30	0.90	6.1	2.07	2.51	5.19					3.5	5.2				350.0	3.7	1.6	Direct runoff at DP H1 Pipe Flow to DP H2
H2	H2		2.56	0.90	6.2	2.30	2.49	5.74													Direct runoff at DP H2
	H2	H1 & H2	4.86	0.90					7.6	4.37	2.33	10.19	3.5	10.2				350.0	3.7	1.6	Combine Flow at DP H2 Pipe flow to DP H3
H3	H3		2.86	0.90	5.0	2.57	2.65	6.81													Direct runoff at DP H3
	H3	H1 , H2, H3	7.72	0.90					9.2	6.95	2.18	15.14									Combine Flow at DP H3 Direct Discharge to Soda Creek
H4	H4		0.40	0.90	5.0	0.36	2.65	0.95													
Sub-basin Y																					
Y1	Y1		2.72	0.90	6.5	2.45	2.45	6.00													Direct Runoff at DP Y1
Y2	Y2		0.27	0.90	5.0	0.24	2.65	0.64													Direct Runoff at DP Y2
	Y2	Y2 & Y3	0.85	0.90					5.8	0.77	2.53	1.94									
Y3	Y3		0.58	0.90	5.0	0.52	2.65	1.38					2.5	1.4				160.0	3.2	0.8	Direct Runoff at DP Y3 Pipe flow to Y2
Y4	Y4		2.90	0.90	7.5	2.61	2.34	6.11													Direct Runoff at DP Y4
	Y2	Y2, Y3 & Y4	3.75	0.90					7.5	3.38	2.34	7.90									Combine Flow at DP Y2 Direct Discharge to Yampa River
Y5	Y5		3.39	0.90	5.9	3.05	2.53	7.72													Direct Runoff at DP Y5
Y6	Y6		0.12	0.90	5.0	0.11	2.65	0.29													Direct Runoff at DP Y6
	Y6	Y6 & Y7	1.85	0.90					6.7	1.67	2.44	4.06	0.8	4.1				240.0	1.8	2.2	Combine flow at DP Y6 Pipe flow to DP Y8
Y7	Y7		1.73	0.90	6.2	1.56	2.49	3.87					1.0	3.9				50.0	2.0	0.4	Direct Runoff at DP Y7 Pipe flow to DP Y6
Y8	Y8		0.11	0.90	5.0	0.10	2.65	0.26													Direct Runoff at DP Y8
	Y8	Y6, Y7 & Y8	1.96	0.90					8.9	1.76	2.21	3.90	1.0	3.9				60.0	2.0	0.5	Combine Flow at DP Y8 Pipe flow to DP Y9
Y9	Y9	Y9	1.71	0.90	6.0	1.54	2.51	3.87													Direct Runoff at DP Y9
	Y9	Y6, Y7, Y8 & Y9	3.67	0.90					9.4	3.30	2.17	7.15	3.3	7.2				390.0	3.6	1.8	Combine Flow at DP Y9 Pipe flow to DP Y10
Y10	Y10		2.98	0.90	5.9	2.68	2.53	6.79													Direct runoff to DP Y10
	Y10	Y6, Y7, Y8, Y9 & Y10	6.65	0.90					11.1	5.99	2.02	12.09									Combine Flow at DP Y10 Direct Discharge to Yampa River

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	**0.78**			DESIGN STORM:	**5-YEAR (minor storm)**
10-year P1 =	0.94	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	1.09	CHECKED BY: KSC	MAJOR BASIN: Soda Creek and Portions of DFA - Yampa	LOCATION:	City of Steamboat Springs, Colorado
100-year P1 =	1.46				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Y11	Y11		2.62	0.90	7.1	2.36	2.39	5.63					2.0	5.6				65.0	2.8	0.4	Direct Runoff at DP Y11 Pipe flow to DP Y12
Y12	Y12		0.33	0.90	5.0	0.30	2.65	0.79													Direct Flow to DP Y12
	Y12	Y11 & Y12	2.95	0.90					7.5	2.66	2.35	6.23	2.1	6.2				190.0	2.9	1.1	Combine flow at DP Y12 Pipe flow to DP Y13
Y13	Y13		0.11	0.90	5.0	0.10	2.65	0.26													Direct runoff to DP Y13
	Y13	Y11, Y12 & Y13	3.06	0.90					8.6	2.75	2.24	6.16	4.6	6.2				263.0	4.3	1.0	Combine flow at DP Y13 Pipe flow to DP Y14
Y14	Y14	Y14	0.29	0.90	5.0	0.26	2.65	0.69													Direct Runoff at DP Y14
	Y14	Y11, Y12, Y13 & Y14	4.87	0.90					9.6	4.38	2.14	9.40									Combine flow at DP Y14 Direct Discharge to Yampa River
Y15	Y15		1.52	0.90	5.0	1.37	2.65	3.62					1.0	3.6				50.0	2.0	0.4	Direct flow at DP Y15 Pipe flow to DP Y14

Notes: Intensity -Duration Curve for Rational Method per equation RA-3 (Urban Drainage)
I = (28.5*P1) / (10+Tc)^.786

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	0.78			DESIGN STORM:	**10-YEAR**
10-year P1 =	**0.94**	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	1.09	CHECKED BY: KSC	MAJOR BASIN: Soda Creek and Portions of DFA - Yampa	LOCATION:	Soda Creek and Portions of DFA - Yampa
100-year P1 =	1.46				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Sub-basin A																					
A1	A1		9.41	0.39	13.7	3.64	2.23	8.10													Direct runoff to DP A1 & Soda Creek
A2	A2		7.41	0.35	13.0	2.60	2.28	5.93													Direct Runoff to DP A2 & Soda Creek
A3	A3		4.02	0.42	13.0	1.69	2.28	3.85													Direct Runoff to DP A3 & Soda Creek
A4	A4		6.48	0.37	13.8	2.41	2.21	5.35													Direct Runoff to DP A4 & Soda Creek
Sub-basin B																					
B1	B1		40.58	0.28	11.3	11.48	2.42	27.79					7.7	27.79				1001.0	5.5	3.0	Direct runoff to DP B1 Ditch flow to DP B3
B2	B2		16.31	0.31	12.7	5.03	2.31	11.59					6.0	11.59				398.0	4.9	1.4	Direct runoff to DP B2 Ditch flow to DP B3
B3	B3		7.88	0.41	10.9	3.23	2.45	7.92													Direct runoff to DP B3
	B3	B1, B2 & B3	64.77	0.30					14.3	19.74	2.18	43.05	3.9	43.05				285.0	3.9	1.2	Combine flow at DP B3 Ditch Flow to DP B4
B4	B4		13.57	0.31	18.4	4.18	1.93	8.05													Direct Runoff to DP B4
	B4	B1, B2, B3 & B4	78.34	0.31					18.4	23.91	1.93	46.10	5.9	46.10				640.0	4.9	2.2	Combine flow at DP B4 Ditch Flow to DP B7
B5	B5		12.33	0.33	15.0	4.13	2.13	8.80													Direct Runoff to DP B5
	B5	B1, B2, B3, B4 & B5	90.67	0.31					20.6	28.04	1.82	50.99	4.4	50.99				118.0	4.2	0.5	Combine flow at DP B5 Ditch Flow to DP B6
B6	B6		12.33	0.42	8.9	5.23	2.65	13.87													Direct runoff to DP B6
	B6	B1, B2, B3, B4, B5 & B6	103.00	0.32					21.1	33.27	1.80	59.78	4.4	59.78				332.0	4.2	1.3	Combine flow at DP B6 Ditch Flow to DP B8
B7	B7		6.17	0.42	12.4	2.59	2.33	6.03													Direct runoff to DP B7 Ditch Flow to DP B10
B8	B8		2.64	0.42	5.6	1.11	3.09	3.43													Direct runoff to DP B8
	B8	B1, B2, B3, B4, B5, B6, B7 & B8	111.81	0.33					22.4	36.97	1.74	64.30	6.9	64.30				412.0	5.3	1.3	Combine flow at DP B8 Ditch Flow to DP B10
B9	B9		5.32	0.42	12.7	2.23	2.30	5.14													Direct runoff to DP B9
B10	B10		2.31	0.42	11.6	0.97	2.40	2.32													Direct runoff to DP B10
	B10	B1, B2, B3, B4, B5, B6, B7, B8, B9 &B10	119.44	0.34					23.7	40.17	1.69	67.74	6.1	67.74				360.0	4.9	1.2	Combine flow at DP B10 Ditch Flow to DP B11
B11	B11		7.30	0.42	13.3	3.07	2.25	6.91													Direct runoff to DP B11
	B11	B1, B2, B3, B4, B5, B6, B7, B8, B9, B10 & B11	126.74	0.34					24.9	43.24	1.64	70.91									Combine flow at DP B11

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	0.78			DESIGN STORM:	**10-YEAR**
10-year P1 =	**0.94**	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	1.09	CHECKED BY: KSC	MAJOR BASIN: Soda Creek and Portions of DFA - Yampa	LOCATION:	Soda Creek and Portions of DFA - Yampa
100-year P1 =	1.46				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Sub-basin C																					
C1	C1		40.20	0.31	14.6	12.36	2.16	26.71					7.5	26.71				50.0	5.5	0.2	Direct runoff to DP C1 Ditch flow to DP C2
C2	C2		8.00	0.32	10.5	2.57	2.49	6.39													Direct runoff to DP C2
	C2	C1 & C2	48.20	0.31					14.8	14.93	2.15	32.10	7.5	32.10				1352.0	5.5	4.1	Combine flow at DP C2 Ditch flow to DP C3
C3	C3		14.17	0.47	12.1	6.73	2.35	15.82													Direct runoff to DP C3
	C3	C1, C2, C6 & C3	70.72	0.35					18.9	25.10	1.91	47.82	5.6	47.82				430.0	4.7	1.5	Combine flow at DP C3 Ditch flow to DP C4
C4	C4		9.25	0.43	8.8	3.96	2.67	10.58													Direct runoff to DP C4
C5	C5		4.06	0.53	8.5	2.14	2.70	5.77													Direct runoff to DP C5
	C5	C1, C2, C3, C4, C5 & C6	84.03	0.37					20.4	31.19	1.83	57.09	7.1	57.09				365.0	5.3	1.1	Combine flow at DP C5 Ditch flow to DP C7
C7	C7		2.78	0.42	6.1	1.17	3.01	3.52													Direct runoff to DP C7
	C7	C1, C2, C3, C4, C5, C6 & C7	86.81	0.37					21.5	32.36	1.78	57.54									Combine flow at DP C7 Pipe outfall to Soda Creek
C6	C6		8.35	0.41	14.8	3.44	2.15	7.39					8.0	7.39				30.0	5.7	0.1	Direct runoff at DP C6
Sub-basin D																					
D1	D1		3.57	0.38	14.3	1.34	2.18	2.92					9.3	2.9				343.0	6.1	0.9	Direct runoff at DP D1 Ditch flow to DP D2
D2	D2		4.70	0.44	9.7	2.07	2.57	5.32													Direct runoff at DP D2
	D2	D1 & D2	8.27	0.41					15.3	3.41	2.12	7.21									Combine flow at DP D2 Outfall to Soda Creek
D3	D3		2.68	0.41	6.3	1.09	2.99	3.27													Direct runoff at DP D3 Outfall to Soda Creek
D4	D4		1.99	0.42	5.0	0.84	3.19	2.66													Direct runoff at DP D4
Sub-basin E																					
E1	E1		17.13	0.40	8.0	6.77	2.76	18.69													Direct runoff at DP E1 Direct Discharge to Soda Creek
E2	E2		4.90	0.41	10.7	2.01	2.47	4.98													Direct runoff at DP E2

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	0.78			DESIGN STORM:	**10-YEAR**
10-year P1 =	**0.94**	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	1.09	CHECKED BY: KSC	MAJOR BASIN: Soda Creek and Portions of DFA - Yampa	LOCATION:	Soda Creek and Portions of DFA - Yampa
100-year P1 =	1.46				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Sub-basin F																					
F1	F1		18.38	0.40	13.3	7.26	2.26	16.41					9.6	16.41				249.0	6.2	0.7	Direct runoff at DP F1 Pipe flow to DP F3
F2	F2		11.85	0.32	10.8	3.84	2.47	9.48					2.0	9.48				1380.0	2.8	8.1	Direct runoff at DP F2 Ditch flow to DP F5
F3	F3		2.42	0.42	6.8	1.02	2.92	2.97													Direct runoff at DP F3
	F3	F1 & F3	20.80	0.40					13.9	8.28	2.21	18.29	2.4	18.29				1081.0	3.1	5.8	Combine flow at DP F3 Pipe flow to DP F5
F4	F4		3.12	0.62	10.2	1.94	2.52	4.90					3.4	4.90				485.0	3.7	2.2	Direct runoff at DP F4 Pipe flow to DP F5
F5	F5		11.26	0.44	17.8	4.91	1.96	9.64													Direct runoff at DP F5
	F5	F1, F2, F3, F4 , F5 & F6	52.09	0.41					19.7	21.20	1.86	39.47	1.0	39.47				53.0	2.0	0.4	Combine flow at DP F5 Pipe flow to DP F7
F6	F6		5.06	0.44	15.3	2.23	2.12	4.71													Direct runoff at DP F6
F7	F7		5.70	0.43	14.4	2.42	2.17	5.27													Direct runoff at DP F7
	F7	F1, F2, F3, F4, F5, F6 & F7	57.79	0.41					20.2	23.62	1.84	43.47	1.7	43.47				343.0	2.6	2.2	Combine flow at DP F7 Ditch flow to DP F8
F8	F8		2.56	0.44	11.9	1.13	2.36	2.66													Direct runoff at DP F8
	F8	F1, F2, F3, F4, F5, F6, F7 & F8	60.35	0.41					22.4	24.75	1.74	43.10									Combine flow at DP F8 Direct Discharge to Soda Creek
F9	F9		3.60	0.45	11.2	1.63	2.43	3.96													Direct runoff at DP F9
Sub-basin G																					
G1	G1		10.55	0.46	17.9	4.82	1.96	9.45													Direct runoff at DP G1 Direct Discharge to Soda Creek
G2	G2		6.22	0.46	15.6	2.84	2.09	5.93													Direct runoff at DP G2 Direct Discharge to Soda Creek
G3	G3		6.48	0.63	14.6	4.11	2.16	8.88					1.5	8.88				635.0	2.4	4.3	Direct runoff to DP G3 Curb flow to DP G4
G4	G4		5.93	0.58	13.0	3.47	2.28	7.91													Direct runoff to DP G4
	G4	G3 & G4	12.41	1.15					18.9	14.26	1.90	27.13									Combine flow at DP G4

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	0.78			DESIGN STORM:	**10-YEAR**
10-year P1 =	**0.94**	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	1.09	CHECKED BY: KSC	MAJOR BASIN: Soda Creek and Portions of DFA - Yampa	LOCATION:	Soda Creek and Portions of DFA - Yampa
100-year P1 =	1.46				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Sub-basin H																					
H1	H1		2.30	0.90	6.1	2.07	3.02	6.25					3.5	6.3				350.0	3.7	1.6	Direct runoff at DP H1 Pipe Flow to DP H2
H2	H2		2.56	0.90	6.2	2.30	3.00	6.92													Direct runoff at DP H2
	H2	H1 & H2	4.86	0.90					7.6	4.37	2.81	12.28	3.5	12.3				350.0	3.7	1.6	Combine Flow at DP H2 Pipe flow to DP H3
H3	H3		2.86	0.90	5.0	2.57	3.19	8.21													Direct runoff at DP H3
	H3		7.72	0.90					9.2	6.95	2.63	18.25									Combine Flow at DP H3 Direct Discharge to Soda Creek
H4	H4		0.40	0.90	5.0	0.36	3.19	1.15													
Sub-basin Y																					
Y1	Y1		2.72	0.92	6.5	2.50	2.95	7.39													Direct Runoff at DP Y1
Y2	Y2		0.27	0.92	5.0	0.25	3.19	0.79													Direct Runoff at DP Y2
	Y2	Y2 & Y3	0.85	0.92					5.8	0.78	3.05	2.39									
Y3	Y3		0.58	0.92	5.0	0.53	3.19	1.70					2.5	1.7				160.0	3.2	0.8	Direct Runoff at DP Y3 Pipe flow to Y2
Y4	Y4		2.90	0.92	7.5	2.67	2.82	7.52													Direct Runoff at DP Y4
	Y2	Y2, Y3 & Y4	3.75	0.90					7.5	3.38	2.82	9.52									Combine Flow at DP Y2 Direct Discharge to Yampa River
Y5	Y5		3.39	0.92	5.9	3.12	3.05	9.51													Direct Runoff at DP Y5
Y6	Y6		0.12	0.92	5.0	0.11	3.19	0.35													Direct Runoff at DP Y6
	Y6	Y6 & Y7	1.85	0.90					6.7	1.67	2.94	4.89	0.8	4.9				240.0	1.8	2.2	Combine flow at DP Y6 Pipe flow to DP Y8
Y7	Y7		1.73	0.92	6.2	1.59	3.00	4.77					1.0	4.8				50.0	2.0	0.4	Direct Runoff at DP Y7 Pipe flow to DP Y6
Y8	Y8		0.11	0.90	5.0	0.10	3.19	0.32													Direct Runoff at DP Y8
	Y8	Y6, Y7 & Y8	1.96	0.90					8.9	1.76	2.66	4.70	1.0	4.7				60.0	2.0	0.5	Combine Flow at DP Y8 Pipe flow to DP Y9
Y9	Y9	Y9	1.71	0.92	6.0	1.57	3.03	4.77													Direct Runoff at DP Y9
	Y9	Y6, Y7, Y8 & Y9	3.67	0.90					9.4	3.30	2.61	8.62	3.3	8.6				390.0	3.6	1.8	Combine Flow at DP Y9 Pipe flow to DP Y10
Y10	Y10		2.98	0.90	5.9	2.68	3.05	8.19													Direct runoff to DP Y10
	Y10	Y6, Y7, Y8, Y9 & Y10	6.65	0.90					11.1	5.99	2.43	14.57									Combine Flow at DP Y10 Direct Discharge to Yampa River
Y11	Y11		2.62	0.90	7.1	2.36	2.88	6.78					2.0	6.8				65.0	2.8	0.4	Direct Runoff at DP Y11

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	0.78			DESIGN STORM:	**10-YEAR**
10-year P1 =	**0.94**	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	1.09	CHECKED BY: KSC	MAJOR BASIN: Soda Creek and Portions of DFA - Yampa	LOCATION:	Soda Creek and Portions of DFA - Yampa
100-year P1 =	1.46				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
																					Pipe flow to DP Y12
Y12	Y12		0.33	0.90	5.0	0.30	3.19	0.95													Direct Flow to DP Y12
	Y12	Y11 & Y12	2.95	0.90					7.5	2.66	2.83	7.50	2.1	7.5				190.0	2.9	1.1	Combine flow at DP Y12 Pipe flow to DP Y13
Y13	Y13		0.11	0.90	5.0	0.10	3.19	0.32													Direct runoff to DP Y13
	Y13	Y11, Y12 & Y13	3.06	0.90					8.6	2.75	2.69	7.42	4.6	7.4				263.0	4.3	1.0	Combine flow at DP Y13 Pipe flow to DP Y14
Y14	Y14	Y14	0.29	0.92	5.0	0.27	3.19	0.85													Direct Runoff at DP Y14
	Y14	Y11, Y12, Y13 & Y14	4.87	0.90					9.6	4.38	2.58	11.32									Combine flow at DP Y14 Direct Discharge to Yampa River
Y15	Y15		1.52	0.90	5.0	1.37	3.19	4.36					1.0	4.4				50.0	2.0	0.4	Direct Runoff at DP Y15 Pipe flow to DP Y14

Notes: Intensity -Duration Curve for Rational Method per equation RA-3 (Urban Drainage)
I = (28.5*P1) / (10+Tc)^.786

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	0.78			DESIGN STORM:	**25-YEAR**
10-year P1 =	0.94	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	**1.09**	CHECKED BY: KSC	MAJOR BASIN: Soda Creek and Portions of DFA - Yampa	LOCATION:	City of Steamboat Springs, Colorado
100-year P1 =	1.46				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Sub-basin A																					
A1	A1		9.41	0.47	13.7	4.46	2.58	11.51													Direct runoff to DP A1 & Soda Creek
A2	A2		7.41	0.45	13.0	3.30	2.65	8.74													Direct Runoff to DP A2 & Soda Creek
A3	A3		4.02	0.50	13.0	2.01	2.65	5.32													Direct Runoff to DP A3 & Soda Creek
A4	A4		6.48	0.46	13.8	3.00	2.57	7.70													Direct Runoff to DP A4 & Soda Creek
Sub-basin B																					
B1	B1		40.58	0.39	11.3	15.92	2.81	44.67					7.7	44.67				1001.0	5.5	3.0	Direct runoff to DP B1 Ditch flow to DP B3
B2	B2		16.31	0.41	12.7	6.72	2.67	17.97					6.0	17.97				398.0	4.9	1.4	Direct runoff to DP B2 Ditch flow to DP B3
B3	B3		7.88	0.49	10.9	3.88	2.85	11.03													Direct runoff to DP B3
	B3	B1, B2 & B3	64.77	0.41					14.3	26.52	2.53	67.08	3.9	67.08				285.0	3.9	1.2	Combine flow at DP B3 Ditch Flow to DP B4
B4	B4		13.57	0.41	18.4	5.59	2.24	12.49													Direct Runoff to DP B4
	B4	B1, B2, B3 & B4	78.34	0.41					18.4	32.11	2.24	71.78	5.9	71.78				640.0	4.9	2.2	Combine flow at DP B4 Ditch Flow to DP B7
B5	B5		12.33	0.43	15.0	5.32	2.47	13.14													Direct Runoff to DP B5
	B5	B1, B2, B3, B4 & B5	90.67	0.41					20.6	37.42	2.11	78.91	4.4	78.91				118.0	4.2	0.5	Combine flow at DP B5 Ditch Flow to DP B6
B6	B6		12.33	0.50	8.9	6.19	3.08	19.05													Direct runoff to DP B6
	B6	B1, B2, B3, B4, B5 & B6	103.00	0.42					21.1	43.61	2.08	90.88	4.4	90.88				332.0	4.2	1.3	Combine flow at DP B6 Ditch Flow to DP B8
B7	B7		6.17	0.50	12.4	3.09	2.70	8.32													Direct runoff to DP B7 Ditch Flow to DP B10
B8	B8		2.64	0.50	5.6	1.32	3.58	4.73													Direct runoff to DP B8
	B8	B1, B2, B3, B4, B5, B6, B7 & B8	111.81	0.43					22.4	48.02	2.02	96.84	6.9	96.84				412.0	5.3	1.3	Combine flow at DP B8 Ditch Flow to DP B10
B9	B9		5.32	0.50	12.7	2.66	2.67	7.10													Direct runoff to DP B9
B10	B10		2.31	0.50	11.6	1.16	2.78	3.21													Direct runoff to DP B10
	B10	B1, B2, B3, B4, B5, B6, B7, B8, B9 &B10	119.44	0.43					23.7	51.83	1.96	101.34	6.1	101.34				360.0	4.9	1.2	Combine flow at DP B10 Ditch Flow to DP B11
B11	B11		7.30	0.50	13.3	3.65	2.61	9.54													Direct runoff to DP B11
	B11	B1, B2, B3, B4, B5, B6, B7, B8, B9, B10 & B11	126.74	0.44					24.9	55.48	1.90	105.50									Combine flow at DP B11

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	0.78			DESIGN STORM:	**25-YEAR**
10-year P1 =	0.94	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	**1.09**	CHECKED BY: KSC	MAJOR BASIN: Soda Creek and Portions of DFA - Yampa	LOCATION:	City of Steamboat Springs, Colorado
100-year P1 =	1.46				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Sub-basin C																					
C1	C1		40.20	0.41	14.6	16.63	2.51	41.65					7.5	41.65				50.0	5.5	0.2	Direct runoff to DP C1 Ditch flow to DP C2
C2	C2		8.00	0.43	10.5	3.40	2.89	9.82													Direct runoff to DP C2
	C2	C1 & C2	48.20	0.42					14.8	20.03	2.49	49.93	7.5	49.93				1352.0	5.5	4.1	Combine flow at DP C2 Ditch flow to DP C3
C3	C3		14.17	0.55	12.1	7.85	2.73	21.39													Direct runoff to DP C3
	C3	C1, C2, C6 & C3	70.72	0.45					18.9	32.00	2.21	70.69	5.6	70.69				430.0	4.7	1.5	Combine flow at DP C3 Ditch flow to DP C4
C4	C4		9.25	0.51	8.8	4.74	3.10	14.69													Direct runoff to DP C4
C5	C5		4.06	0.59	8.5	2.41	3.13	7.55													Direct runoff to DP C5
	C5	C1, C2, C3, C4, C5 & C6	84.03	0.47					20.4	39.14	2.12	83.08	7.1	83.08				365.0	5.3	1.1	Combine flow at DP C5 Ditch flow to DP C7
C7	C7		2.78	0.50	6.1	1.39	3.49	4.86													Direct runoff to DP C7
	C7	C1, C2, C3, C4, C5, C6 & C7	86.81	0.47					21.5	40.53	2.06	83.57									Combine flow at DP C7 Pipe outfall to Soda Creek
C6	C6		8.35	0.49	14.8	4.12	2.49	10.27					8.0	10.27				30.0	5.7	0.1	Direct runoff at DP C6
Sub-basin D																					
D1	D1		3.57	0.46	14.3	1.66	2.53	4.19					9.3	4.2				343.0	6.1	0.9	Direct runoff at DP D1 Ditch flow to DP D2
D2	D2		4.70	0.51	9.7	2.40	2.98	7.14													Direct runoff at DP D2
	D2	D1 & D2	8.27	0.49					15.3	4.06	2.45	9.95									Combine flow at DP D2 Outfall to Soda Creek
D3	D3		2.68	0.49	6.3	1.30	3.47	4.52													Direct runoff at DP D3 Outfall to Soda Creek
D4	D4		1.99	0.50	5.0	1.00	3.70	3.68													Direct runoff at DP D4
Sub-basin E																					
E1	E1		17.13	0.48	8.0	8.23	3.20	26.33													Direct runoff at DP E1 Direct Discharge to Soda Creek
E2	E2		4.90	0.49	10.7	2.41	2.87	6.92													Direct runoff at DP E2

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	0.78			DESIGN STORM:	**25-YEAR**
10-year P1 =	0.94	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	**1.09**	CHECKED BY: KSC	MAJOR BASIN: Soda Creek and Portions of DFA - Yampa	LOCATION:	City of Steamboat Springs, Colorado
100-year P1 =	1.46				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Sub-basin F																					
F1	F1		18.38	0.48	13.3	8.83	2.62	23.13					9.6	23.13				249.0	6.2	0.7	Direct runoff at DP F1 Pipe flow to DP F3
F2	F2		11.85	0.42	10.8	5.03	2.86	14.41					2.0	14.41				1380.0	2.8	8.1	Direct runoff at DP F2 Ditch flow to DP F5
F3	F3		2.42	0.50	6.8	1.21	3.39	4.10													Direct runoff at DP F3
	F3	F1 & F3	20.80	0.48					13.9	10.04	2.56	25.72	2.4	25.72				1081.0	3.1	5.8	Combine flow at DP F3 Pipe flow to DP F5
F4	F4		3.12	0.68	10.2	2.11	2.92	6.17					3.4	6.17				485.0	3.7	2.2	Direct runoff at DP F4 Pipe flow to DP F5
F5	F5		11.26	0.51	17.8	5.72	2.28	13.03													Direct runoff at DP F5
	F5	F1, F2, F3, F4 , F5 & F6	52.09	0.49					19.7	25.49	2.16	55.01	1.0	55.01				53.0	2.0	0.4	Combine flow at DP F5 Pipe flow to DP F7
F6	F6		5.06	0.51	15.3	2.58	2.46	6.34													Direct runoff at DP F6
F7	F7		5.70	0.50	14.4	2.87	2.52	7.24													Direct runoff at DP F7
	F7	F1, F2, F3, F4, F5, F6 & F7	57.79	0.49					20.2	28.36	2.13	60.51	1.7	60.51				343.0	2.6	2.2	Combine flow at DP F7 Ditch flow to DP F8
F8	F8		2.56	0.51	11.9	1.31	2.74	3.58													Direct runoff at DP F8
	F8	F1, F2, F3, F4, F5, F6, F7 & F8	60.35	0.49					22.4	29.66	2.02	59.90									Combine flow at DP F8 Direct Discharge to Soda Creek
F9	F9		3.60	0.52	11.2	1.88	2.82	5.30													Direct runoff at DP F9
Sub-basin G																					
G1	G1		10.55	0.53	17.9	5.56	2.27	12.64													Direct runoff at DP G1 Direct Discharge to Soda Creek
G2	G2		6.22	0.53	15.6	3.27	2.43	7.93													Direct runoff at DP G2 Direct Discharge to Soda Creek
G3	G3		6.48	0.68	14.6	4.43	2.51	11.12					1.5	11.12				635.0	2.4	4.3	Direct runoff to DP G3 Curb flow to DP G4
G4	G4		5.93	0.64	13.0	3.79	2.64	10.03													Direct runoff to DP G4
	G4	G3 & G4	12.41	1.36					18.9	16.82	2.21	37.14									Combine flow at DP G4

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	0.78			DESIGN STORM:	**25-YEAR**
10-year P1 =	0.94	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	**1.09**	CHECKED BY: KSC	MAJOR BASIN: Soda Creek and Portions of DFA - Yampa	LOCATION:	City of Steamboat Springs, Colorado
100-year P1 =	1.46				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Sub-basin H																					
H1	H1		2.30	0.90	6.1	2.07	3.50	7.25					3.5	7.2				350.0	3.7	1.6	Direct runoff at DP H1 Pipe Flow to DP H2
H2	H2		2.56	0.90	6.2	2.30	3.48	8.02													Direct runoff at DP H2
	H2	H1 & H2	4.86	0.90					7.6	4.37	3.26	14.24	3.5	14.2				350.0	3.7	1.6	Combine Flow at DP H2 Pipe flow to DP H3
H3	H3		2.86	0.90	5.0	2.57	3.70	9.52													Direct runoff at DP H3
	H3		7.72	0.90					9.2	6.95	3.05	21.16									Combine Flow at DP H3 Direct Discharge to Soda Creek
H4	H4		0.40	0.90	5.0	0.36	3.70	1.33													
Sub-basin Y																					
Y1	Y1		2.72	0.94	6.5	2.56	3.42	8.76													Direct Runoff at DP Y1
Y2	Y2		0.27	0.94	5.0	0.25	3.70	0.94													Direct Runoff at DP Y2
	Y2	Y2 & Y3	0.85	0.94					5.8	0.80	3.54	2.83									
Y3	Y3		0.58	0.94	5.0	0.55	3.70	2.02					2.5	2.0				160.0	3.2	0.8	Direct Runoff at DP Y3 Pipe flow to Y2
Y4	Y4		2.90	0.94	7.5	2.73	3.27	8.91													Direct Runoff at DP Y4
	Y2	Y2, Y3 & Y4	3.75	0.90					7.5	3.38	3.27	11.04									Combine Flow at DP Y2 Direct Discharge to Yampa River
Y5	Y5		3.39	0.94	5.9	3.19	3.54	11.27													Direct Runoff at DP Y5
Y6	Y6		0.12	0.94	5.0	0.11	3.70	0.42													Direct Runoff at DP Y6
	Y6	Y6 & Y7	1.85	0.90					6.7	1.67	3.40	5.67	0.8	5.7				240.0	1.8	2.2	Combine flow at DP Y6 Pipe flow to DP Y8
Y7	Y7		1.73	0.94	6.2	1.63	3.47	5.65					1.0	5.6				50.0	2.0	0.4	Direct Runoff at DP Y7 Pipe flow to DP Y6
Y8	Y8		0.11	0.90	5.0	0.10	3.70	0.37													Direct Runoff at DP Y8
	Y8	Y6, Y7 & Y8	1.96	0.90					8.9	1.76	3.09	5.45	1.0	5.4				60.0	2.0	0.5	Combine Flow at DP Y8 Pipe flow to DP Y9
Y9	Y9	Y9	1.71	0.94	6.0	1.61	3.51	5.65													Direct Runoff at DP Y9
	Y9	Y6, Y7, Y8 & Y9	3.67	0.90					9.4	3.30	3.03	10.00	3.3	10.0				390.0	3.6	1.8	Combine Flow at DP Y9 Pipe flow to DP Y10
Y10	Y10		2.98	0.90	5.9	2.68	3.54	9.49													Direct runoff to DP Y10
	Y10	Y6, Y7, Y8, Y9 & Y10	6.65	0.90					11.1	5.99	2.82	16.90									Combine Flow at DP Y10 Direct Discharge to Yampa River
Y11	Y11		2.62	0.90	7.1	2.36	3.33	7.86					2.0	7.9				65.0	2.8	0.4	Direct Runoff at DP Y11

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	0.78			DESIGN STORM:	**25-YEAR**
10-year P1 =	0.94	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	**1.09**	CHECKED BY: KSC	MAJOR BASIN: Soda Creek and Portions of DFA - Yampa	LOCATION:	City of Steamboat Springs, Colorado
100-year P1 =	1.46				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	**DESIGN POINT**	**AREA DESIG.**	**AREA (Acres)**	**RUNOFF COEFF**	**Tc (min)**	**C A (Acres)**	**I (in/hour)**	**Q (cfs)**	**Tc (min)**	**(C A) (Acres)**	**I (in/hour)**	**Q (cfs)**	**SLOPE (%)**	**STREET FLOW (cfs)**	**DESIGN FLOW (cfs)**	**SLOPE (%)**	**PIPE SIZE**	**LENGTH (ft)**	**VELOCITY (fps)**	**Tt (min)**	REMARKS
																					Pipe flow to DP Y12
Y12	Y12		0.33	0.90	5.0	0.30	3.70	1.10													Direct Flow to DP Y12
	Y12	Y11 & Y12	2.95	0.90					7.5	2.66	3.28	8.70	2.1	8.7				190.0	2.9	1.1	Combine flow at DP Y12 Pipe flow to DP Y13
Y13	Y13		0.11	0.90	5.0	0.10	3.70	0.37													Direct runoff to DP Y13
	Y13	Y11, Y12 & Y13	3.06	0.90					8.6	2.75	3.12	8.61	4.6	8.6				263.0	4.3	1.0	Combine flow at DP Y13 Pipe flow to DP Y14
Y14	Y14	Y14	0.29	0.94	5.0	0.27	3.70	1.01													Direct Runoff at DP Y14
	Y14	Y11, Y12, Y13 & Y14	4.87	0.90					9.6	4.38	3.00	13.13									Combine flow at DP Y14 Direct Discharge to Yampa River
Y15	Y15		1.52	0.90	5.0	1.37	3.70	5.06					1.0	5.1				50.0	2.0	0.4	Direct Runoff at DP Y15 Pipe flow to DP Y14

Notes: Intensity -Duration Curve for Rational Method per equation RA-3 (Urban Drainage)
I = (28.5*P1) / (10+Tc)^.786

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	0.78			DESIGN STORM:	**100-YEAR (major storm)**
10-year P1 =	0.94	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	1.09	CHECKED BY: KSC	MAJOR BASIN: Soda Creek and Portions of DFA - Yampa	LOCATION:	City of Steamboat Springs, Colorado
100-year P1 =	**1.46**				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Sub-basin A																					
A1	A1		9.41	0.57	13.7	5.32	3.46	18.40													Direct runoff to DP A1 & Soda Creek
A2	A2		7.41	0.55	13.0	4.08	3.54	14.45													Direct Runoff to DP A2 & Soda Creek
A3	A3		4.02	0.58	13.0	2.33	3.54	8.26													Direct Runoff to DP A3 & Soda Creek
A4	A4		6.48	0.56	13.8	3.63	3.44	12.47													Direct Runoff to DP A4 & Soda Creek
Sub-basin B																					
B1	B1		40.58	0.52	11.3	21.15	3.76	79.51					7.7	79.51				1001.0	5.5	3.0	Direct runoff to DP B1 Ditch flow to DP B3
B2	B2		16.31	0.53	12.7	8.68	3.58	31.08					6.0	31.08				398.0	4.9	1.4	Direct runoff to DP B2 Ditch flow to DP B3
B3	B3		7.88	0.58	10.9	4.54	3.81	17.29													Direct runoff to DP B3
	B3	B1, B2 & B3	64.77	0.53					14.3	34.37	3.39	116.44	3.9	116.44				285.0	3.9	1.2	Combine flow at DP B3 Ditch Flow to DP B4
B4	B4		13.57	0.53	18.4	7.22	2.99	21.62													Direct Runoff to DP B4
	B4	B1, B2, B3 & B4	78.34	0.53					18.4	41.58	2.99	124.53	5.9	124.53				640.0	4.9	2.2	Combine flow at DP B4 Ditch Flow to DP B7
B5	B5		12.33	0.54	15.0	6.71	3.31	22.21													Direct Runoff to DP B5
	B5	B1, B2, B3, B4 & B5	90.67	0.53					20.6	48.29	2.82	136.41	4.4	136.41				118.0	4.2	0.5	Combine flow at DP B5 Ditch Flow to DP B6
B6	B6		12.33	0.58	8.9	7.18	4.12	29.58													Direct runoff to DP B6
	B6	B1, B2, B3, B4, B5 & B6	103.00	0.54					21.1	55.47	2.79	154.82	4.4	154.82				332.0	4.2	1.3	Combine flow at DP B6 Ditch Flow to DP B8
B7	B7		6.17	0.58	12.4	3.58	3.61	12.93													Direct runoff to DP B7 Ditch Flow to DP B10
B8	B8		2.64	0.58	5.6	1.53	4.80	7.35													Direct runoff to DP B8
	B8	B1, B2, B3, B4, B5, B6, B7 & B8	111.81	0.54					22.4	60.58	2.70	163.65	6.9	163.65				412.0	5.3	1.3	Combine flow at DP B8 Ditch Flow to DP B10
B9	B9		5.32	0.58	12.7	3.09	3.57	11.02													Direct runoff to DP B9
B10	B10		2.31	0.58	11.6	1.34	3.72	4.98													Direct runoff to DP B10
	B10	B1, B2, B3, B4, B5, B6, B7, B8, B9 &B10	119.44	0.54					23.7	65.00	2.62	170.24	6.1	170.24				360.0	4.9	1.2	Combine flow at DP B10 Ditch Flow to DP B11
B11	B11		7.30	0.58	13.3	4.23	3.50	14.82													Direct runoff to DP B11
	B11	B1, B2, B3, B4, B5, B6, B7, B8, B9, B10 & B11	126.74	0.55					24.9	69.24	2.55	176.35									Combine flow at DP B11

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	0.78			DESIGN STORM:	**100-YEAR (major storm)**
10-year P1 =	0.94	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	1.09	CHECKED BY: KSC	MAJOR BASIN: Soda Creek and Portions of DFA - Yampa	LOCATION:	City of Steamboat Springs, Colorado
100-year P1 =	**1.46**				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	**DESIGN POINT**	**AREA DESIG.**	**AREA (Acres)**	**RUNOFF COEFF**	**Tc (min)**	**C A (Acres)**	**I (in/hour)**	**Q (cfs)**	**Tc (min)**	**(C A) (Acres)**	**I (in/hour)**	**Q (cfs)**	**SLOPE (%)**	**STREET FLOW (cfs)**	**DESIGN FLOW (cfs)**	**SLOPE (%)**	**PIPE SIZE**	**LENGTH (ft)**	**VELOCITY (fps)**	**Tt (min)**	REMARKS
Sub-basin C																					
C1	C1		40.20	0.54	14.6	21.66	3.36	72.68					7.5	72.68				50.0	5.5	0.2	Direct runoff to DP C1
																					Ditch flow to DP C2
C2	C2		8.00	0.55	10.5	4.38	3.87	16.96													Direct runoff to DP C2
	C2	C1 & C2	48.20	0.54					14.8	26.04	3.34	86.97	7.5	86.97				1352.0	5.5	4.1	Combine flow at DP C2
																					Ditch flow to DP C3
C3	C3		14.17	0.64	12.1	9.08	3.65	33.15													Direct runoff to DP C3
	C3	C1, C2, C6 & C3	70.72	0.56					18.9	39.94	2.96	118.19	5.6	118.19				430.0	4.7	1.5	Combine flow at DP C3
																					Ditch flow to DP C4
C4	C4		9.25	0.61	8.8	5.61	4.15	23.27													Direct runoff to DP C4
C5	C5		4.06	0.66	8.5	2.68	4.20	11.26													Direct runoff to DP C5
	C5	C1, C2, C3, C4, C5 & C6	84.03	0.57					20.4	48.23	2.84	137.10	7.1	137.10				365.0	5.3	1.1	Combine flow at DP C5
																					Ditch flow to DP C7
C7	C7		2.78	0.58	6.1	1.61	4.68	7.55													Direct runoff to DP C7
	C7	C1, C2, C3, C4, C5, C6 & C7	86.81	0.57					21.5	49.84	2.76	137.64									Combine flow at DP C7
																					Pipe outfall to Soda Creek
C6	C6		8.35	0.58	14.8	4.81	3.34	16.07					8.0	16.07				30.0	5.7	0.1	Direct runoff at DP C6
Sub-basin D																					
D1	D1		3.57	0.56	14.3	2.00	3.39	6.78					9.3	6.8				343.0	6.1	0.9	Direct runoff at DP D1
																					Ditch flow to DP D2
D2	D2		4.70	0.59	9.7	2.77	3.99	11.07													Direct runoff at DP D2
	D2	D1 & D2	8.27	0.58					15.3	4.78	3.29	15.69									Combine flow at DP D2
																					Outfall to Soda Creek
D3	D3		2.68	0.58	6.3	1.54	4.65	7.17													Direct runoff at DP D3
																					Outfall to Soda Creek
D4	D4		1.99	0.58	5.0	1.15	4.95	5.72													Direct runoff at DP D4
Sub-basin E																					
E1	E1		17.13	0.57	8.0	9.76	4.29	41.83													Direct runoff at DP E1
																					Direct Discharge to Soda Creek
E2	E2		4.90	0.58	10.7	2.82	3.84	10.84													Direct runoff at DP E2

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	0.78			DESIGN STORM:	**100-YEAR (major storm)**
10-year P1 =	0.94	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	1.09	CHECKED BY: KSC	MAJOR BASIN: Soda Creek and Portions of DFA - Yampa	LOCATION:	City of Steamboat Springs, Colorado
100-year P1 =	**1.46**				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Sub-basin F																					
F1	F1		18.38	0.57	13.3	10.47	3.51	36.71					9.6	36.71				249.0	6.2	0.7	Direct runoff at DP F1 Pipe flow to DP F3
F2	F2		11.85	0.54	10.8	6.39	3.84	24.49					2.0	24.49				1380.0	2.8	8.1	Direct runoff at DP F2 Ditch flow to DP F5
F3	F3		2.42	0.58	6.8	1.40	4.54	6.37													Direct runoff at DP F3
	F3	F1 & F3	20.80	0.57					13.9	11.87	3.43	40.72	2.4	40.72				1081.0	3.1	5.8	Combine flow at DP F3 Pipe flow to DP F5
F4	F4		3.12	0.73	10.2	2.28	3.92	8.92					3.4	8.92				485.0	3.7	2.2	Direct runoff at DP F4 Pipe flow to DP F5
F5	F5		11.26	0.59	17.8	6.62	3.05	20.20													Direct runoff at DP F5
	F5	F1, F2, F3, F4 , F5 & F6	52.09	0.58					19.7	30.14	2.89	87.14	1.0	87.14				53.0	2.0	0.4	Combine flow at DP F5 Pipe flow to DP F7
F6	F6		5.06	0.59	15.3	2.99	3.29	9.82													Direct runoff at DP F6
F7	F7		5.70	0.58	14.4	3.32	3.38	11.22													Direct runoff at DP F7
	F7	F1, F2, F3, F4, F5, F6 & F7	57.79	0.58					20.2	33.46	2.86	95.63	1.7	95.63				343.0	2.6	2.2	Combine flow at DP F7 Ditch flow to DP F8
F8	F8		2.56	0.59	11.9	1.51	3.67	5.55													Direct runoff at DP F8
	F8	F1, F2, F3, F4, F5, F6, F7 & F8	60.35	0.58					22.4	34.97	2.70	94.59									Combine flow at DP F8 Direct Discharge to Soda Creek
F9	F9		3.60	0.60	11.2	2.15	3.78	8.11													Direct runoff at DP F9
Sub-basin G																					
G1	G1		10.55	0.60	17.9	6.32	3.04	19.22													Direct runoff at DP G1 Direct Discharge to Soda Creek
G2	G2		6.22	0.60	15.6	3.72	3.25	12.08													Direct runoff at DP G2 Direct Discharge to Soda Creek
G3	G3		6.48	0.74	14.6	4.79	3.36	16.08					1.5	16.08				635.0	2.4	4.3	Direct runoff to DP G3 Curb flow to DP G4
G4	G4		5.93	0.70	13.0	4.16	3.54	14.73													Direct runoff to DP G4
	G4	G3 & G4	12.41	1.61					18.9	19.92	2.96	58.90									Combine flow at DP G4

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	0.78			DESIGN STORM:	**100-YEAR (major storm)**
10-year P1 =	0.94	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	1.09	CHECKED BY: KSC	MAJOR BASIN: Soda Creek and Portions of DFA - Yampa	LOCATION:	City of Steamboat Springs, Colorado
100-year P1 =	**1.46**				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Sub-basin H																					
H1	H1		2.30	0.90	6.1	2.07	4.69	9.71					3.5	9.7				350.0	3.7	1.6	Direct runoff at DP H1 Pipe Flow to DP H2
H2	H2		2.56	0.90	6.2	2.30	4.66	10.74													Direct runoff at DP H2
	H2	H1 & H2	4.86	0.90					7.6	4.37	4.36	19.07	3.5	19.1				350.0	3.7	1.6	Combine Flow at DP H2 Pipe flow to DP H3
H3	H3		2.86	0.90	5.0	2.57	4.95	12.75													Direct runoff at DP H3
	H3		7.72	0.90					9.2	6.95	4.08	28.35									Combine Flow at DP H3 Direct Discharge to Soda Creek
H4	H4		0.40	0.90	5.0	0.36	4.95	1.78													
Sub-basin Y																					
Y1	Y1		2.72	0.96	6.5	2.61	4.59	11.98													Direct Runoff at DP Y1
Y2	Y2		0.27	0.96	5.0	0.26	4.95	1.28													Direct Runoff at DP Y2
	Y2	Y2 & Y3	0.85	0.96					5.8	0.82	4.74	3.87									
Y3	Y3		0.58	0.96	5.0	0.56	4.95	2.76					2.5	2.8				160.0	3.2	0.8	Direct Runoff at DP Y3 Pipe flow to Y2
Y4	Y4		2.90	0.96	7.5	2.78	4.38	12.19													Direct Runoff at DP Y4
	Y2	Y2, Y3 & Y4	3.75	0.90					7.5	3.38	4.38	14.78									Combine Flow at DP Y2 Direct Discharge to Yampa River
Y5	Y5		3.39	0.96	5.9	3.25	4.74	15.41													Direct Runoff at DP Y5
Y6	Y6		0.12	0.96	5.0	0.12	4.95	0.57													Direct Runoff at DP Y6
	Y6	Y6 & Y7	1.85	0.90					6.7	1.67	4.56	7.59	0.8	7.6				240.0	1.8	2.2	Combine flow at DP Y6 Pipe flow to DP Y8
Y7	Y7		1.73	0.96	6.2	1.66	4.65	7.73					1.0	7.7				50.0	2.0	0.4	Direct Runoff at DP Y7 Pipe flow to DP Y6
Y8	Y8		0.11	0.90	5.0	0.10	4.95	0.49													Direct Runoff at DP Y8
	Y8	Y6, Y7 & Y8	1.96	0.90					8.9	1.76	4.14	7.30	1.0	7.3				60.0	2.0	0.5	Combine Flow at DP Y8 Pipe flow to DP Y9
Y9	Y9	Y9	1.71	0.96	6.0	1.64	4.71	7.72													Direct Runoff at DP Y9
	Y9	Y6, Y7, Y8 & Y9	3.67	0.90					9.4	3.30	4.05	13.39	3.3	13.4				390.0	3.6	1.8	Combine Flow at DP Y9 Pipe flow to DP Y10
Y10	Y10		2.98	0.90	5.9	2.68	4.74	12.72													Direct runoff to DP Y10
	Y10	Y6, Y7, Y8, Y9 & Y10	6.65	0.90					11.1	5.99	3.78	22.63									Combine Flow at DP Y10

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	0.78			DESIGN STORM:	**100-YEAR (major storm)**
10-year P1 =	0.94	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	1.09	CHECKED BY: KSC	MAJOR BASIN: Soda Creek and Portions of DFA - Yampa	LOCATION:	City of Steamboat Springs, Colorado
100-year P1 =	**1.46**				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	**DESIGN POINT**	**AREA DESIG.**	**AREA (Acres)**	**RUNOFF COEFF**	**Tc (min)**	**C A (Acres)**	**I (in/hour)**	**Q (cfs)**	**Tc (min)**	**(C A) (Acres)**	**I (in/hour)**	**Q (cfs)**	**SLOPE (%)**	**STREET FLOW (cfs)**	**DESIGN FLOW (cfs)**	**SLOPE (%)**	**PIPE SIZE**	**LENGTH (ft)**	**VELOCITY (fps)**	**Tt (min)**	REMARKS
																					Direct Discharge to Yampa River
Y11	Y11		2.62	0.90	7.1	2.36	4.47	10.53					2.0	10.5				65.0	2.8	0.4	Direct Runoff at DP Y11
																					Pipe flow to DP Y12
Y12	Y12		0.33	0.90	5.0	0.30	4.95	1.47													Direct Flow to DP Y12
	Y12	Y11 & Y12	2.95	0.90					7.5	2.66	4.39	11.65	2.1	11.7				190.0	2.9	1.1	Combine flow at DP Y12
																					Pipe flow to DP Y13
Y13	Y13		0.11	0.90	5.0	0.10	4.95	0.49													Direct runoff to DP Y13
	Y13	Y11, Y12 & Y13	3.06	0.90					8.6	2.75	4.19	11.53	4.6	11.5				263.0	4.3	1.0	Combine flow at DP Y13
																					Pipe flow to DP Y14
Y14	Y14	Y14	0.29	0.96	5.0	0.28	4.95	1.38													Direct Runoff at DP Y14
	Y14	Y11, Y12, Y13 & Y14	4.87	0.90					9.6	4.38	4.01	17.59									Combine flow at DP Y14
																					Direct Discharge to Yampa River
Y15	Y15		1.52	0.90	5.0	1.37	4.95	6.77					1.0	6.8				50.0	2.0	0.4	Direct Runoff at DP Y15
																					Pipe flow to DP Y14

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J3 Engineering Consultants, Inc.

Notes: Intensity -Duration Curve for Rational Method per equation RA-3 (Urban Drainage)
I = (28.5*P1) / (10+Tc)^.786

Old Town Drainage Study

Rational Calculations Summary ~ BUTCHERKNIFE CREEK AND PORTIONS OF DFA - YAMPA

Design Point	Tributary Drainage Basins	Tributary Area (acres)	5 -Year Runoff (cfs)	10 -Year Runoff (cfs)	25 -Year Runoff (cfs)	100 -Year Runoff (cfs)
A1	A1	5.92	3.7	6.1	9.2	15.6
A2	A2	5.53	4.7	7.0	9.8	15.6
A3	A3	3.08	2.5	3.8	5.4	8.6
A4	A4	2.42	1.7	2.4	3.3	5.1
B1	B1	2.95	2.1	3.4	4.9	8.1
B2	B2	4.06	2.9	4.0	5.4	8.2
B3	B3	3.93	2.7	3.9	5.2	8.1
C1	C1	5.67	3.4	4.9	6.6	10.2
C2	C2	6.48	4.6	6.4	8.5	12.9
C2	C1 & C2	12.15	7.3	10.2	13.7	20.9
C3	C3	4.69	3.4	4.7	6.3	9.6
C3	C1, C2 & C3	16.84	9.2	12.9	17.3	26.5
C4	C4	6.57	4.3	6.2	8.6	13.3
D1	D1	4.89	3.3	4.8	6.5	10.2
E1	E1	3.23	2.5	3.4	4.6	7.0
E2	E2	1.59	1.5	2.1	2.9	4.3
E2	E1 & E2	4.82	3.7	5.1	6.8	10.3
F1	F1	3.52	5.1	6.6	8.2	11.8
F2	F2	0.78	1.9	2.3	2.7	3.7
F3	F3	3.38	5.4	7.0	8.6	12.3
F3	F1, F2 & F3	7.68	11.3	14.4	17.8	25.3
F4	F4	3.48	7.5	9.3	11.2	15.6
F4	F1, F2, F3 & F4	11.16	17.3	22.0	26.8	37.8
F5	F5	3.10	7.4	9.1	10.8	14.7

Old Town Drainage Study

Rational Calculations Summary ~ BUTCHERKNIFE CREEK AND PORTIONS OF DFA - YAMPA

Design Point	Tributary Drainage Basins	Tributary Area (acres)	5 -Year Runoff (cfs)	10 -Year Runoff (cfs)	25 -Year Runoff (cfs)	100 -Year Runoff (cfs)
Y20	Y20	2.07	4.9	6.0	7.1	9.7
Y21	Y21	1.26	3.0	3.7	4.4	6.0
Y22	Y22	3.26	7.7	9.5	11.3	15.4
Y22	Y20 & Y22	5.33	11.7	14.1	16.3	21.9
Y23b	Y23b	7.85	5.5	7.9	10.7	16.7
Y23a	Y23a	4.59	3.6	5.1	6.8	10.6
Y23a	Y23a and Y23b	12.44	8.2	11.7	15.8	24.5
Y23	Y23	3.14	3.0	4.1	5.5	8.3
Y23	Y23, Y23a and Y23b	15.58	10.3	14.6	19.7	30.4
Y24	Y24	1.00	1.0	1.2	1.4	1.8
Y25	Y25	0.32	0.8	0.9	1.1	1.4
Y24	Y24 & Y25	1.32	1.7	2.0	2.3	3.1
Y26	Y26	3.41	8.1	9.8	11.3	15.2
Y26	Y21, Y23 & Y26	20.25	17.3	23.2	29.6	43.7
Y27	Y27	3.32	7.9	9.5	11.0	14.8
Y27	Y21, Y23, Y26 & Y27	23.57	22.1	28.9	36.2	52.4
Y28	Y28	1.68	4.0	4.8	5.6	7.5
Y28	Y24, Y25 & Y28	3.00	5.1	6.2	7.2	9.6
Y29	Y29	1.79	4.3	5.1	6.0	8.0
Y29	Y24, Y25, Y28 & Y29	4.79	8.8	10.6	12.3	16.4
Y30	Y30	1.37	3.3	3.9	4.6	6.1
Y30	Y30	6.16	11.5	13.9	16.1	21.6

Parcel Data Table

Butcherknife Creek and Portions of DFA - Yampa

Job No.: 50500101
Date: 4/16/2009
Calculated By: JDM
Checked By: KSC

Parcel Data Table

Area	Land Use Category	Density (DU/acre)	C5	C10	C25	C100	I (%)	Comments
Undeveloped	Undeveloped	---	0.18	0.28	0.39	0.52	5	Undeveloped Land ~ Historic Flow Analysis
Commercial (on- & off-site)	Commercial	---	0.90	0.92	0.94	0.96	100	Commercial Areas
Schools/Churches	Schools & Churches	---	0.40	0.46	0.53	0.60	50	Schools & Churches
Residential 1	Single Family Detached	---	0.35	0.42	0.50	0.58	40	Low Density
Residential 2	Single Family Detached	---	0.37	0.44	0.51	0.59	45	Medium Density
Residential 3	Single Family Detached	---	0.40	0.46	0.53	0.60	50	High Density
Open Space	Open Space, Park and Landscape Tracts	---	0.18	0.28	0.39	0.52	5	Open Space, parks and landscape tracts

*Percent Impervious values for the Residential land uses were generated off three sample blocks. Please see the attached exhibits for location and methodology.
**Runoff Coefficients are from the City of Steamboat Springs Engineering Standards, Table 5.6.1 Design Runoff Coefficients
***Percent Impervious Values for Undeveloped and Open Space have been increased to 5%
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Composite Imperviousness Calculations

Butcherknife Creek and Portions of DFA - Yampa

City of Steamboat Springs, Colorado

Job No.: 50500101
Date: 4/16/09
Calculated By: JDM
Checked By: KSC

Major Basin	Sub-Basin	Area	Parcel Imperviousness							Composite Imperviousness
			Undeveloped	Commercial (on- & off-site)	Schools/Churches	Residential 1	Residential 2	Residential 3	Open Space	
		(acres)	5	100	50	40	45	50	5	(%)
A										
	A1	5.92	0.00	0.00	0.00	2.10	0.00	0.00	3.82	17.4
	A2	5.53	0.00	0.00	0.00	1.07	3.10	0.00	1.36	34.2
	A3	3.08	0.00	0.00	0.00	0.85	1.31	0.00	0.92	31.7
	A4	2.42	0.00	0.00	0.00	1.58	0.84	0.00	0.00	41.7
	Sum	**16.95**	**0.00**	**0.00**	**0.00**	**5.60**	**5.25**	**0.00**	**6.10**	29.0
B										
	B1	2.95	0.00	0.00	0.00	0.23	1.24	0.00	1.48	24.5
	B2	4.06	0.00	0.00	0.00	0.00	0.00	4.06	0.00	50.0
	B3	3.93	0.00	0.00	0.00	0.00	3.93	0.00	0.00	45.0
	Sum	**10.94**	**0.00**	**0.00**	**0.00**	**0.23**	**5.17**	**4.06**	**1.48**	41.3
C										
	C1	5.67	0.00	0.00	0.00	0.00	5.67	0.00	0.00	45.0
	C2	6.48	0.00	0.00	0.00	0.00	0.00	6.48	0.00	50.0
	C3	4.69	0.00	0.00	0.00	0.00	0.00	4.69	0.00	50.0
	C4	6.57	0.00	0.00	0.00	5.03	1.54	0.00	0.00	41.2
	Sum	**23.41**	**0.00**	**0.00**	**0.00**	**5.03**	**7.21**	**11.17**	**0.00**	46.3
D										
	Y23b	7.85	0.00	0.00	0.00	2.04	5.81	0.00	0.00	43.7
	Y23a	4.59	0.00	0.00	0.00	0.00	4.59	0.00	0.00	45.0
	D1	4.89	0.00	0.00	0.00	0.00	4.44	0.00	0.45	41.3
	Sum	**17.33**	**0.00**	**0.00**	**0.00**	**2.04**	**14.84**	**0.00**	**0.45**	43.4

Composite Imperviousness Calculations

Butcherknife Creek and Portions of DFA - Yampa

City of Steamboat Springs, Colorado

Job No.: 50500101
Date: 4/16/09
Calculated By: JDM
Checked By: KSC

Major Basin	Sub-Basin	Area	Parcel Imperviousness							Composite Imperviousness
			Undeveloped	Commercial (on- & off-site)	Schools/Churches	Residential 1	Residential 2	Residential 3	Open Space	
		(acres)	5	100	50	40	45	50	5	(%)
E										
	E1	3.23	0.00	0.00	1.24	0.00	0.00	1.99	0.00	50.0
	E2	1.59	0.00	0.00	0.00	0.00	0.00	1.59	0.00	50.0
	Sum	**4.82**	**0.00**	**0.00**	**1.24**	**0.00**	**0.00**	**3.58**	**0.00**	50.0
F										
	F1	3.52	0.00	1.55	0.65	0.00	0.00	1.32	0.00	72.0
	F2	0.78	0.00	0.78	0.00	0.00	0.00	0.00	0.00	100.0
	F3	3.38	0.00	1.73	0.00	0.00	1.65	0.00	0.00	73.2
	F4	3.48	0.00	3.05	0.00	0.00	0.00	0.00	0.43	88.3
	F5	3.10	0.00	3.10	0.00	0.00	0.00	0.00	0.00	100.0
	Sum	**14.26**	**0.00**	**10.21**	**0.65**	**0.00**	**1.65**	**1.32**	**0.43**	83.9
Y										
	Y20	2.07	0.00	2.07	0.00	0.00	0.00	0.00	0.00	100.0
	Y21	1.26	0.00	1.26	0.00	0.00	0.00	0.00	0.00	100.0
	Y22	3.26	0.00	3.26	0.00	0.00	0.00	0.00	0.00	100.0
	Y23	3.14	0.00	0.00	0.00	0.00	0.00	3.14	0.00	50.0
	Y23a	4.59	0.00	0.00	0.00	0.00	4.59	0.00	0.00	45.0
	Y23b	7.85	0.00	0.00	0.00	2.04	5.81	0.00	0.00	43.7
	Y24	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	50.0
	Y25	0.32	0.00	0.32	0.00	0.00	0.00	0.00	0.00	100.0
	Y26	3.41	0.00	3.41	0.00	0.00	0.00	0.00	0.00	100.0
	Y27	3.32	0.00	3.32	0.00	0.00	0.00	0.00	0.00	100.0
	Y28	1.68	0.00	1.68	0.00	0.00	0.00	0.00	0.00	100.0
	Y29	1.79	0.00	1.79	0.00	0.00	0.00	0.00	0.00	100.0
	Y30	1.37	0.00	1.37	0.00	0.00	0.00	0.00	0.00	100.0
	Sum	**35.06**	**0.00**	**18.48**	**0.00**	**2.04**	**10.40**	**4.14**	**0.00**	74.3
TOTAL	**Sum**	**122.77**	**0.00**	**28.69**	**1.89**	**14.94**	**44.52**	**24.27**	**8.46**	55.6

Composite "C" Calculations

Butcherknife Creek and Portions of DFA - Yampa
City of Steamboat Springs, Colorado

Job No.: 50500101
Date: 4/16/09
Calculated By: JDM
Checked By: KSC

Basin	Sub-Basin	Area (acres)	2 Year Calculation								5 Year Calculation								10 Year Calculation								25 Year Calculation								100 Year Calculation							
			Area Type								Area Type								Area Type								Area Type								Area Type							
			Undeveloped	Commercial (on- & off-site)	Schools/Churches	Residential 1	Residential 2	Residential 3	Open Space	C2	Undeveloped	Commercial (on- & off-site)	Schools/Churches	Residential 1	Residential 2	Residential 3	Open Space	C5	Undeveloped	Commercial (on- & off-site)	Schools/Churches	Residential 1	Residential 2	Residential 3	Open Space	C10	Undeveloped	Commercial (on- & off-site)	Schools/Churches	Residential 1	Residential 2	Residential 3	Open Space	C25	Undeveloped	Commercial (on- & off-site)	Schools/Churches	Residential 1	Residential 2	Residential 3	Open Space	C100
			0.08	0.89	0.34	0.28	0.31	0.34	0.08		0.18	0.90	0.40	0.35	0.37	0.40	0.18		0.28	0.92	0.46	0.42	0.44	0.46	0.28		0.39	0.94	0.53	0.50	0.51	0.53	0.39		0.52	0.96	0.60	0.58	0.59	0.60	0.52	
A																																										
	A1	5.92	0.00	0.00	0.00	2.10	0.00	0.00	3.82	0.15	0.00	0.00	0.00	2.10	0.00	0.00	3.82	0.24	0.00	0.00	0.00	2.10	0.00	0.00	3.82	0.33	0.00	0.00	0.00	2.10	0.00	0.00	3.82	0.43	0.00	0.00	0.00	2.10	0.00	0.00	3.82	0.54
	A2	5.53	0.00	0.00	0.00	1.07	3.10	0.00	1.36	0.25	0.00	0.00	0.00	1.07	3.10	0.00	1.36	0.32	0.00	0.00	0.00	1.07	3.10	0.00	1.36	0.40	0.00	0.00	0.00	1.07	3.10	0.00	1.36	0.48	0.00	0.00	0.00	1.07	3.10	0.00	1.36	0.57
	A3	3.08	0.00	0.00	0.00	0.85	1.31	0.00	0.92	0.23	0.00	0.00	0.00	0.85	1.31	0.00	0.92	0.31	0.00	0.00	0.00	0.85	1.31	0.00	0.92	0.39	0.00	0.00	0.00	0.85	1.31	0.00	0.92	0.47	0.00	0.00	0.00	0.85	1.31	0.00	0.92	0.57
	A4	2.42	0.00	0.00	0.00	1.58	0.84	0.00	0.00	0.29	0.00	0.00	0.00	1.58	0.84	0.00	0.00	0.36	0.00	0.00	0.00	1.58	0.84	0.00	0.00	0.43	0.00	0.00	0.00	1.58	0.84	0.00	0.00	0.50	0.00	0.00	0.00	1.58	0.84	0.00	0.00	0.58
B																																										
	B1	2.95	0.00	0.00	0.00	0.23	1.24	0.00	1.48	0.19	0.00	0.00	0.00	0.23	1.24	0.00	1.48	0.27	0.00	0.00	0.00	0.23	1.24	0.00	1.48	0.36	0.00	0.00	0.00	0.23	1.24	0.00	1.48	0.45	0.00	0.00	0.00	0.23	1.24	0.00	1.48	0.55
	B2	4.06	0.00	0.00	0.00	0.00	0.00	4.06	0.00	0.34	0.00	0.00	0.00	0.00	0.00	4.06	0.00	0.40	0.00	0.00	0.00	0.00	0.00	4.06	0.00	0.46	0.00	0.00	0.00	0.00	0.00	4.06	0.00	0.53	0.00	0.00	0.00	0.00	0.00	4.06	0.00	0.60
	B3	3.93	0.00	0.00	0.00	0.00	3.93	0.00	0.00	0.31	0.00	0.00	0.00	0.00	3.93	0.00	0.00	0.37	0.00	0.00	0.00	0.00	3.93	0.00	0.00	0.44	0.00	0.00	0.00	0.00	3.93	0.00	0.00	0.51	0.00	0.00	0.00	0.00	3.93	0.00	0.00	0.59
C																																										
	C1	5.67	0.00	0.00	0.00	0.00	5.67	0.00	0.00	0.31	0.00	0.00	0.00	0.00	5.67	0.00	0.00	0.37	0.00	0.00	0.00	0.00	5.67	0.00	0.00	0.44	0.00	0.00	0.00	0.00	5.67	0.00	0.00	0.51	0.00	0.00	0.00	0.00	5.67	0.00	0.00	0.59
	C2	6.48	0.00	0.00	0.00	0.00	0.00	6.48	0.00	0.34	0.00	0.00	0.00	0.00	0.00	6.48	0.00	0.40	0.00	0.00	0.00	0.00	0.00	6.48	0.00	0.46	0.00	0.00	0.00	0.00	0.00	6.48	0.00	0.53	0.00	0.00	0.00	0.00	0.00	6.48	0.00	0.60
	C3	4.69	0.00	0.00	0.00	0.00	0.00	4.69	0.00	0.34	0.00	0.00	0.00	0.00	0.00	4.69	0.00	0.40	0.00	0.00	0.00	0.00	0.00	4.69	0.00	0.46	0.00	0.00	0.00	0.00	0.00	4.69	0.00	0.53	0.00	0.00	0.00	0.00	0.00	4.69	0.00	0.60
	C4	6.57	0.00	0.00	0.00	5.03	1.54	0.00	0.00	0.29	0.00	0.00	0.00	5.03	1.54	0.00	0.00	0.35	0.00	0.00	0.00	5.03	1.54	0.00	0.00	0.42	0.00	0.00	0.00	5.03	1.54	0.00	0.00	0.50	0.00	0.00	0.00	5.03	1.54	0.00	0.00	0.58
D																																										
	Y23b	7.85	0.00	0.00	0.00	2.04	5.81	0.00	0.00	0.30	0.00	0.00	0.00	2.04	5.81	0.00	0.00	0.36	0.00	0.00	0.00	2.04	5.81	0.00	0.00	0.43	0.00	0.00	0.00	2.04	5.81	0.00	0.00	0.51	0.00	0.00	0.00	2.04	5.81	0.00	0.00	0.59
	Y23a	4.59	0.00	0.00	0.00	0.00	4.59	0.00	0.00	0.31	0.00	0.00	0.00	0.00	4.59	0.00	0.00	0.37	0.00	0.00	0.00	0.00	4.59	0.00	0.00	0.44	0.00	0.00	0.00	0.00	4.59	0.00	0.00	0.51	0.00	0.00	0.00	0.00	4.59	0.00	0.00	0.59
	D1	4.89	0.00	0.00	0.00	0.00	4.44	0.00	0.45	0.29	0.00	0.00	0.00	0.00	4.44	0.00	0.45	0.35	0.00	0.00	0.00	0.00	4.44	0.00	0.45	0.43	0.00	0.00	0.00	0.00	4.44	0.00	0.45	0.50	0.00	0.00	0.00	0.00	4.44	0.00	0.45	0.58
E																																										
	E1	3.23	0.00	0.00	1.24	0.00	0.00	1.99	0.00	0.34	0.00	0.00	1.24	0.00	0.00	1.99	0.00	0.40	0.00	0.00	1.24	0.00	0.00	1.99	0.00	0.46	0.00	0.00	1.24	0.00	0.00	1.99	0.00	0.53	0.00	0.00	1.24	0.00	0.00	1.99	0.00	0.60
	E2	1.59	0.00	0.00	0.00	0.00	0.00	1.59	0.00	0.34	0.00	0.00	0.00	0.00	0.00	1.59	0.00	0.40	0.00	0.00	0.00	0.00	0.00	1.59	0.00	0.46	0.00	0.00	0.00	0.00	0.00	1.59	0.00	0.53	0.00	0.00	0.00	0.00	0.00	1.59	0.00	0.60

Composite "C" Calculations

Butcherknife Creek and Portions of DFA - Yampa
City of Steamboat Springs, Colorado

Job No.: 50500101
Date: 4/16/09
Calculated By: JDM
Checked By: KSC

Basin	Sub-Basin	Area (acres)	2 Year Calculation								5 Year Calculation								10 Year Calculation								25 Year Calculation								100 Year Calculation							
			Area Type								Area Type								Area Type								Area Type								Area Type							
			Undeveloped	Commercial (on- & off-site)	Schools/Churches	Residential 1	Residential 2	Residential 3	Open Space	C2	Undeveloped	Commercial (on- & off-site)	Schools/Churches	Residential 1	Residential 2	Residential 3	Open Space	C5	Undeveloped	Commercial (on- & off-site)	Schools/Churches	Residential 1	Residential 2	Residential 3	Open Space	C10	Undeveloped	Commercial (on- & off-site)	Schools/Churches	Residential 1	Residential 2	Residential 3	Open Space	C25	Undeveloped	Commercial (on- & off-site)	Schools/Churches	Residential 1	Residential 2	Residential 3	Open Space	C100
			0.08	0.89	0.34	0.28	0.31	0.34	0.08		0.18	0.90	0.40	0.35	0.37	0.40	0.18		0.28	0.92	0.46	0.42	0.44	0.46	0.28		0.39	0.94	0.53	0.50	0.51	0.53	0.39		0.52	0.96	0.60	0.58	0.59	0.60	0.52	
F																																										
	F1	3.52	0.00	1.55	0.65	0.00	0.00	1.32	0.00	0.58	0.00	1.55	0.65	0.00	0.00	1.32	0.00	0.62	0.00	1.55	0.65	0.00	0.00	1.32	0.00	0.66	0.00	1.55	0.65	0.00	0.00	1.32	0.00	0.71	0.00	1.55	0.65	0.00	0.00	1.32	0.00	0.76
	F2	0.78	0.00	0.78	0.00	0.00	0.00	0.00	0.00	0.89	0.00	0.78	0.00	0.00	0.00	0.00	0.00	0.90	0.00	0.78	0.00	0.00	0.00	0.00	0.00	0.92	0.00	0.78	0.00	0.00	0.00	0.00	0.00	0.94	0.00	0.78	0.00	0.00	0.00	0.00	0.00	0.96
	F3	3.38	0.00	1.73	0.00	0.00	1.65	0.00	0.00	0.61	0.00	1.73	0.00	0.00	1.65	0.00	0.00	0.64	0.00	1.73	0.00	0.00	1.65	0.00	0.00	0.69	0.00	1.73	0.00	0.00	1.65	0.00	0.00	0.73	0.00	1.73	0.00	0.00	1.65	0.00	0.00	0.78
	F4	3.48	0.00	3.05	0.00	0.00	0.00	0.00	0.43	0.79	0.00	3.05	0.00	0.00	0.00	0.00	0.43	0.81	0.00	3.05	0.00	0.00	0.00	0.00	0.43	0.84	0.00	3.05	0.00	0.00	0.00	0.00	0.43	0.87	0.00	3.05	0.00	0.00	0.00	0.00	0.43	0.91
	F5	3.10	0.00	3.10	0.00	0.00	0.00	0.00	0.00	0.89	0.00	3.10	0.00	0.00	0.00	0.00	0.00	0.90	0.00	3.10	0.00	0.00	0.00	0.00	0.00	0.92	0.00	3.10	0.00	0.00	0.00	0.00	0.00	0.94	0.00	3.10	0.00	0.00	0.00	0.00	0.00	0.96
Y																																										
	Y20	2.07	0.00	2.07	0.00	0.00	0.00	0.00	0.00	0.89	0.00	2.07	0.00	0.00	0.00	0.00	0.00	0.90	0.00	2.07	0.00	0.00	0.00	0.00	0.00	0.92	0.00	2.07	0.00	0.00	0.00	0.00	0.00	0.94	0.00	2.07	0.00	0.00	0.00	0.00	0.00	0.96
	Y21	1.26	0.00	1.26	0.00	0.00	0.00	0.00	0.00	0.89	0.00	1.26	0.00	0.00	0.00	0.00	0.00	0.90	0.00	1.26	0.00	0.00	0.00	0.00	0.00	0.92	0.00	1.26	0.00	0.00	0.00	0.00	0.00	0.94	0.00	1.26	0.00	0.00	0.00	0.00	0.00	0.96
	Y22	3.26	0.00	3.26	0.00	0.00	0.00	0.00	0.00	0.89	0.00	3.26	0.00	0.00	0.00	0.00	0.00	0.90	0.00	3.26	0.00	0.00	0.00	0.00	0.00	0.92	0.00	3.26	0.00	0.00	0.00	0.00	0.00	0.94	0.00	3.26	0.00	0.00	0.00	0.00	0.00	0.96
	Y23	3.14	0.00	0.00	0.00	0.00	0.00	3.14	0.00	0.34	0.00	0.00	0.00	0.00	0.00	3.14	0.00	0.40	0.00	0.00	0.00	0.00	0.00	3.14	0.00	0.46	0.00	0.00	0.00	0.00	0.00	3.14	0.00	0.53	0.00	0.00	0.00	0.00	0.00	3.14	0.00	0.60
	Y23a	4.59	0.00	0.00	0.00	0.00	4.59	0.00	0.00	0.31	0.00	0.00	0.00	0.00	4.59	0.00	0.00	0.37	0.00	0.00	0.00	0.00	4.59	0.00	0.00	0.44	0.00	0.00	0.00	0.00	4.59	0.00	0.00	0.51	0.00	0.00	0.00	0.00	4.59	0.00	0.00	0.59
	Y23b	7.85	0.00	0.00	0.00	2.04	5.81	0.00	0.00	0.30	0.00	0.00	0.00	2.04	5.81	0.00	0.00	0.36	0.00	0.00	0.00	2.04	5.81	0.00	0.00	0.43	0.00	0.00	0.00	2.04	5.81	0.00	0.00	0.51	0.00	0.00	0.00	2.04	5.81	0.00	0.00	0.59
	Y24	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.34	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.40	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.46	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.53	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.60
	Y25	0.32	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.89	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.90	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.92	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.94	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.96
	Y26	3.41	0.00	3.41	0.00	0.00	0.00	0.00	0.00	0.89	0.00	3.41	0.00	0.00	0.00	0.00	0.00	0.90	0.00	3.41	0.00	0.00	0.00	0.00	0.00	0.92	0.00	3.41	0.00	0.00	0.00	0.00	0.00	0.94	0.00	3.41	0.00	0.00	0.00	0.00	0.00	0.96
	Y27	3.32	0.00	3.32	0.00	0.00	0.00	0.00	0.00	0.89	0.00	3.32	0.00	0.00	0.00	0.00	0.00	0.90	0.00	3.32	0.00	0.00	0.00	0.00	0.00	0.92	0.00	3.32	0.00	0.00	0.00	0.00	0.00	0.94	0.00	3.32	0.00	0.00	0.00	0.00	0.00	0.96
	Y28	1.68	0.00	1.68	0.00	0.00	0.00	0.00	0.00	0.89	0.00	1.68	0.00	0.00	0.00	0.00	0.00	0.90	0.00	1.68	0.00	0.00	0.00	0.00	0.00	0.92	0.00	1.68	0.00	0.00	0.00	0.00	0.00	0.94	0.00	1.68	0.00	0.00	0.00	0.00	0.00	0.96
	Y29	1.79	0.00	1.79	0.00	0.00	0.00	0.00	0.00	0.89	0.00	1.79	0.00	0.00	0.00	0.00	0.00	0.90	0.00	1.79	0.00	0.00	0.00	0.00	0.00	0.92	0.00	1.79	0.00	0.00	0.00	0.00	0.00	0.94	0.00	1.79	0.00	0.00	0.00	0.00	0.00	0.96
	Y30	1.37	0.00	1.37	0.00	0.00	0.00	0.00	0.00	0.89	0.00	1.37	0.00	0.00	0.00	0.00	0.00	0.90	0.00	1.37	0.00	0.00	0.00	0.00	0.00	0.92	0.00	1.37	0.00	0.00	0.00	0.00	0.00	0.94	0.00	1.37	0.00	0.00	0.00	0.00	0.00	0.96

TIME OF CONCENTRATION

Butcherknife Creek and Portions of DFA - Yampa

4/16/2009

Job No.: 50500101
Date: 4/16/09
Calculated By: JDM
Checked By: KSC

BASIN	SUB-BASIN DATA			INITIAL/OVERLAND TIME (Tc)			TRAVEL TIME (Tt)						Rational Tc	Tc Check for Urban Catchments		FINAL Tc	CONVEYANCE REMARKS
	DESIG:	AREA (acres)	C_5	LENGTH (ft)	SLOPE (ft/ft)	Ti (min)	LENGTH (ft)	AVG. SLOPE DY	AVG. SLOPE (%)	Conv. Type*	VEL (fps)	Tt (min)	COMP Tc (min)	TOTAL LENGTH (ft)	Tc=(L/180)+10 (min)	(min)	
A	A1	5.92	0.24	82	0.300	4.6	359	96.0	26.7	5	7.8	0.8	5.3	441	12.5	**5.3**	Grass Swale
	A2	5.53	0.32	54	0.220	3.7	370	69.0	18.6	5	6.5	1.0	4.7	424	12.4	**5.0**	Grass Swale
	A3	3.08	0.31	54	0.300	3.4	190	51.0	26.8	5	7.8	0.4	3.8	244	11.4	**5.0**	Grass Swale
	A4	2.42	0.36	55	0.030	6.9	571	62.0	10.9	5	4.9	1.9	8.8	626	13.5	**8.8**	Grass Swale
B	B1	2.95	0.27	76	0.020	10.4	357	8.0	2.2	5	2.2	2.6	13.0	433	12.4	**12.4**	Grass Swale
	B2	4.06	0.40	116	0.025	10.1	720	9.0	1.3	5	1.7	7.2	17.2	836	14.6	**14.6**	Grass Swale
	B3	3.93	0.37	115	0.020	11.2	493	7.0	1.4	5	1.8	4.6	15.8	608	13.4	**13.4**	Grass Swale
C	C1	5.67	0.37	122	0.020	11.6	1274	23.0	1.8	5	2.0	10.5	22.1	1396	17.8	**17.8**	Grass Swale
	C2	6.48	0.40	102	0.020	10.2	790	12.0	1.5	5	1.8	7.1	17.3	892	15.0	**15.0**	Grass Swale
	C3	4.69	0.40	61	0.020	7.9	727	12.0	1.7	5	1.9	6.3	14.1	788	14.4	**14.1**	Grass Swale
	C4	6.57	0.35	70	0.030	7.8	805	11.0	1.4	6	2.3	5.7	13.6	875	14.9	**13.6**	Paved Gutter
D	Y23b	7.85	0.36	123	0.057	8.3	982	39.0	4.0	6	4.0	4.1	12.4	1105	16.1	**12.4**	Paved Gutter
	Y23a	4.59	0.37	85	0.059	6.8	895	42.0	4.7	6	4.3	3.4	10.2	980	15.4	**10.2**	Paved Gutter
	D1	4.89	0.35	80	0.100	5.6	868	10.0	1.2	6	2.1	6.7	12.4	948	15.3	**12.4**	Paved Gutter
E	E1	3.23	0.40	108	0.028	9.4	423	5.0	1.2	6	2.2	3.2	12.6	531	13.0	**12.6**	Paved Gutter
	E2	1.59	0.40	22	0.020	4.7	265	3.0	1.1	6	2.1	2.1	6.8	287	11.6	**6.8**	Paved Gutter

TIME OF CONCENTRATION

Butcherknife Creek and Portions of DFA - Yampa

4/16/2009

Job No.: 50500101
Date: 4/16/09
Calculated By: JDM
Checked By: KSC

BASIN	SUB-BASIN DATA			INITIAL/OVERLAND TIME (Tc)			TRAVEL TIME (Tt)						Rational Tc	Tc Check for Urban Catchments		FINAL Tc	CONVEYANCE REMARKS
	DESIG:	AREA (acres)	C_5	LENGTH (ft)	SLOPE (ft/ft)	Ti (min)	LENGTH (ft)	AVG. SLOPE DY	AVG. SLOPE (%)	Conv. Type*	VEL (fps)	Tt (min)	COMP Tc (min)	TOTAL LENGTH (ft)	Tc=(L/180)+10 (min)	(min)	
F	F1	3.52	0.62	43	0.020	4.5	453	8.0	1.8	6	2.7	2.8	7.4	496	12.8	**7.4**	Paved Gutter
	F2	0.78	0.90	15	0.020	1.1	300	5.0	1.7	6	2.6	1.9	3.0	315	11.8	**5.0**	Paved Gutter
	F3	3.38	0.64	98	0.030	5.7	117	5.0	4.3	6	4.1	0.5	6.2	215	11.2	**6.2**	Paved Gutter
	F4	3.48	0.81	82	0.030	3.3	210	7.0	3.3	6	3.7	1.0	4.2	292	11.6	**5.0**	Paved Gutter
	F5	3.10	0.90	23	0.030	1.2	338	15.0	4.4	6	4.2	1.3	2.5	361	12.0	**5.0**	Paved Gutter
Y	Y20	2.07	0.90	40	0.020	1.8	491	7.0	1.4	6	2.4	3.4	5.2	531	13.0	**5.2**	Paved Gutter
	Y21	1.26	0.90	30	0.010	2.0	415	6.0	1.4	6	2.4	2.9	4.9	445	12.5	**5.0**	Paved Gutter
	Y22	3.26	0.90	28	0.020	1.5	478	6.0	1.3	6	2.2	3.6	5.1	506	12.8	**5.1**	Paved Gutter
	Y23	3.14	0.40	28	0.020	5.3	580	30.0	5.2	6	4.5	2.1	7.4	608	13.4	**7.4**	Paved Gutter
	Y23a	4.59	0.37	85	0.059	6.8	895	42.0	4.7	6	4.3	3.4	10.2	980	15.4	**10.2**	Paved Gutter
	Y23b	7.85	0.36	123	0.057	8.3	982	39.0	4.0	6	4.0	4.1	12.4	1105	16.1	**12.4**	Paved Gutter
	Y24	1.00	0.40	70	0.060	5.9	290	18.0	6.2	6	5.0	1.0	6.8	360	12.0	**6.8**	Paved Gutter
	Y25	0.32	0.90	40	0.020	1.8	330	2.0	0.6	6	1.6	3.5	5.3	370	12.1	**5.3**	Paved Gutter
	Y26	3.41	0.90	50	0.080	1.3	380	12.0	3.2	6	3.6	1.8	3.1	430	12.4	**5.0**	Paved Gutter
	Y27	3.32	0.90	57	0.020	2.2	517	12.0	2.3	6	3.0	2.8	5.0	574	13.2	**5.0**	Paved Gutter
	Y28	1.68	0.90	26	0.020	1.5	302	2.0	0.7	6	1.6	3.1	4.6	328	11.8	**5.0**	Paved Gutter
	Y29	1.79	0.90	15	0.020	1.1	176	2.0	1.1	6	2.1	1.4	2.5	191	11.1	**5.0**	Paved Gutter
	Y30	1.37	0.90	20	0.020	1.3	200	4.0	2.0	6	2.8	1.2	2.5	220	11.2	**5.0**	Paved Gutter

** Note: Conveyance Coefficients - Type 1-Heavy Meadow, Type 2-Tillage/field, Type 3-Short Pasture & Lawn, Type 4-Nearly Bare Ground, Type 5-Grassed Waterway, Type 6-Paved Areas & Shallow Paved Swales.*

J3 Engineering Consultants, Inc.

P:\Jobs\Steamboat Springs\Old Town Masterplan\MasterPlan\Drainage Calculations\3rd Submittal\[BK_Old-Town_Rational.xls]Tc

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	**0.78**			DESIGN STORM:	**5-YEAR (minor storm)**
10-year P1 =	0.94	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	1.09	CHECKED BY: KSC	MAJOR BASIN: Butcherknife Creek and Portions of DFA - Yampa	LOCATION:	City of Steamboat Springs, Colorado
100-year P1 =	1.46				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Sub-basin A																					
A1	A1		5.92	0.24	5.3	1.42	2.60	3.70													Direct runoff to DP A1 & ButcherKnife Creek
A2	A2		5.53	0.32	5.0	1.77	2.65	4.67													Direct Runoff to DP A2 & ButcherKnife Creek
A3	A3		3.08	0.31	5.0	0.95	2.65	2.51													Direct Runoff to DP A3 & ButcherKnife Creek
A4	A4		2.42	0.36	12.4	0.86	1.93	1.67													Direct Runoff to DP A4 & ButcherKnife Creek
Sub-basin B																					
B1	B1		2.95	0.27	5.0	0.81	2.65	2.13													Direct runoff to DP B1 & ButcherKnife Creek
B2	B2		4.06	0.40	14.6	1.62	1.79	2.91													Direct runoff to DP B2 & ButcherKnife Creek
B3	B3		3.93	0.37	13.4	1.45	1.87	2.71													Direct runoff to DP B3 & ButcherKnife Creek
Sub-basin C																					
C1	C1		5.67	0.37	17.8	2.10	1.63	3.42					1.5	3.42				286.0	2.4	1.9	Direct runoff to DP C1 Ditch flow to DP C2
C2	C2		6.48	0.40	15.0	2.59	1.77	4.60													Direct runoff to DP C2
	C2	C1 & C2	12.15	0.39					19.7	4.69	1.55	7.25	1.5	7.25				560.0	2.4	3.8	Combine flow at DP C2 Ditch flow to DP C3
C3	C3		4.69	0.40	14.1	1.88	1.82	3.41													Direct runoff to DP C3
	C3	C1, C2 & C3	16.84	0.39					23.5	6.57	1.41	9.23									Combine flow at DP C3 Outfall to ButcherKnife Creek
C4	C4		6.57	0.35	13.6	2.33	1.85	4.32													Direct runoff to DP C4ButcherKnife Creek Outfall to ButcherKnife Creek
Sub-basin D																					
D1	D1		4.89	0.35	12.6	1.72	1.92	3.31													Direct runoff at DP D3 Outfall to ButcherKnife Creek
Sub-basin E																					
E1	E1		3.23	0.40	12.6	1.29	1.92	2.48							2.48	1.0	18	55.0	5.9	0.2	Direct runoff at DP E1 Pipe Flow to DP E2
E2	E2		1.59	0.40	6.8	0.64	2.42	1.54													Direct runoff at DP E2
	E2		4.82	0.40					12.7	1.93	1.91	3.68									Combine Flow at DP E2 Outfall to ButcherKnife Creek

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	**0.78**			DESIGN STORM:	**5-YEAR (minor storm)**
10-year P1 =	0.94	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	1.09	CHECKED BY: KSC	MAJOR BASIN: Butcherknife Creek and Portions of DFA - Yampa	LOCATION:	City of Steamboat Springs, Colorado
100-year P1 =	1.46				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Sub-basin F																					
F1	F1		3.52	0.62	7.4	2.18	2.36	5.15							5.15	1.0	18	441.0	5.9	1.2	Direct runoff at DP F1 Pipe Flow to DP F3
F2	F2		0.78	0.90	5.0	0.70	2.65	1.86							1.86	1.0	18	55.0	5.9	0.2	Direct runoff at DP F2 Pipe Flow to DP F3
F3	F3		3.38	0.64	6.2	2.17	2.49	5.40													Direct runoff at DP F3
	F3	F1, F2, & F3	7.68	0.66					8.6	5.05	2.23	11.29			11.29	1.0	36	220.0	9.1	0.4	Combine Flow at DP F3 Pipe Flow to DP F4
F4	F4		3.48	0.81	5.0	2.82	2.65	7.47													Direct runoff at DP F4
	F4	F1, F2, F3 & F4	11.16	0.71					9.0	7.87	2.20	17.30									Combine Flow at DP F4 Pipe outfall to ButcherKnife Creek
F5	F5		3.10	0.90	5.0	2.79	2.65	7.38							7.38	1.0	18	55.0	5.9	0.2	Direct runoff to DP C4ButcherKnife Creek
Sub-basin Y																					
Y20	Y20		2.07	0.90	5.2	1.86	2.61	4.87							4.87	1.0	12	395.0	4.6	1.4	Direct runoff at DP Y20 Pipe Flow to DP Y22
Y21	Y21		1.26	0.90	5.0	1.13	2.65	3.00							3.00	1.0	12	70.0	4.6	0.3	Direct runoff at DP Y21 Pipe Flow to DP Y26
Y22	Y22		3.26	0.90	5.1	2.93	2.64	7.73													Direct runoff at DP Y22
	Y22	Y20 & Y22	5.33	0.90					6.7	4.80	2.43	11.67									Combine Flow at DP Y22 Direct Discharge to Yampa River
Y23b	Y23b		7.85	0.36	12.4	2.86	1.93	5.53					4.2	5.53				550.0	4.1	2.2	Direct runoff at DP Y23b Curb flow to DP Y23a
Y23a	Y23a		4.59	0.37	10.2	1.70	2.09	3.55													Direct runoff at DP Y23a
	Y23a	Y23a and Y23b	12.44	0.37					14.6	4.56	1.79	8.17			8.17	3.0	18	330.0	10.7	0.5	Combine runoff to DP 23a Pipe flow to DP 23
Y23	Y23		3.14	0.40	7.4	1.26	2.35	2.95													Direct Runoff at DP Y23
	Y23	Y23, Y23a and Y23b	15.58	0.37					15.1	5.82	1.76	10.26			10.26	3.0	18	380.0	10.7	0.6	Combine runoff at DP Y23 Pipe Flow to DP Y26
Y24	Y24		1.00	0.40	6.8	0.40	2.42	0.97													Direct Runoff at DP Y24
Y25	Y25		0.32	0.90	5.0	0.29	2.65	0.76							0.76	1.0	12	50.0	4.6	0.2	Direct Runoff at DP Y25 Pipe Flow to DP Y28
	Y24	Y24 & Y25	1.32	0.52					6.8	0.69	2.42	1.66			1.66	2.1	18	380.0	8.8	0.7	Pipe Flow to DP Y27
Y26	Y26		3.41	0.90	5.0	3.07	2.65	8.12													Direct Runoff at DP Y26
	Y26	Y21, Y23 & Y26	20.25	0.49					15.7	10.02	1.73	17.34			17.34	3.1	18	380.0	10.9	0.6	Combine Flow at DP Y26 Pipe Flow to DP Y27
Y27	Y27		3.32	0.90	5.0	2.99	2.65	7.91													Direct Flow at DP Y27
	Y27	Y21, Y23, Y26 & Y27	23.57	0.55					16.3	13.01	1.70	22.12									Combine Flow at DP Y27 Direct Discharge to Yampa River
Y28	Y28		1.68	0.90	5.0	1.51	2.65	4.00													Direct Runoff at DP Y28
	Y28	Y24, Y25 & Y28	3.00	0.73					7.5	2.20	2.34	5.15			5.15	2.4	18	210.0	9.5	0.4	Combine Flow at DP Y28 Pipe Flow to DP Y29
Y29	Y29		1.79	0.90	5.0	1.61	2.65	4.26													Direct Runoff at DP Y29
	Y29	Y24, Y25, Y28 & Y29	4.79	0.80					7.9	3.81	2.30	8.77			8.77	5.9	18	170.0	15.4	0.2	Combine Flow at DP Y29 Pipe Flow to DP Y30
Y30	Y30		1.37	0.90	5.0	1.23	2.65	3.26													Direct Runoff to DP Y30
	Y30	Y24, Y25, Y28, Y29 & Y30	6.16	0.82					8.1	5.04	2.28	11.52									Combine Flow at DP Y30 Direct Discharge to Yampa River

Notes: Intensity -Duration Curve for Rational Method per equation RA-3 (Urban Drainage)
I = (28.5*P1) / (10+Tc)^.786

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	0.78			DESIGN STORM:	**10-YEAR**
10-year P1 =	**0.94**	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	1.09	CHECKED BY: KSC	MAJOR BASIN: Butcherknife Creek and Portions of DFA - Yampa	LOCATION:	Butcherknife Creek and Portions of DFA - Yampa
100-year P1 =	1.46				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Sub-basin A																					
A1	A1		5.92	0.33	5.3	1.95	3.13	6.11													Direct runoff to DP A1 & ButcherKnife Creek
A2	A2		5.53	0.40	5.0	2.19	3.19	7.00													Direct Runoff to DP A2 & ButcherKnife Creek
A3	A3		3.08	0.39	5.0	1.19	3.19	3.80													Direct Runoff to DP A3 & ButcherKnife Creek
A4	A4		2.42	0.43	12.4	1.03	2.33	2.40													Direct Runoff to DP A4 & ButcherKnife Creek
Sub-basin B																					
B1	B1		2.95	0.36	5.0	1.06	3.19	3.37													Direct runoff to DP B1 & ButcherKnife Creek
B2	B2		4.06	0.46	14.6	1.87	2.16	4.03													Direct runoff to DP B2 & ButcherKnife Creek
B3	B3		3.93	0.44	13.4	1.73	2.25	3.89													Direct runoff to DP B3 & ButcherKnife Creek
Sub-basin C																					
C1	C1		5.67	0.44	17.8	2.49	1.97	4.90					1.5	4.90				286.0	2.4	1.9	Direct runoff to DP C1 Ditch flow to DP C2
C2	C2		6.48	0.46	15.0	2.98	2.14	6.37													Direct runoff to DP C2
	C2	C1 & C2	12.15	0.45					19.7	5.48	1.86	10.20	1.5	10.20				560.0	2.4	3.8	Combine flow at DP C2 Ditch flow to DP C3
C3	C3		4.69	0.46	14.1	2.16	2.19	4.73													Direct runoff to DP C3
	C3	C1, C2 & C3	16.84	0.45					23.5	7.63	1.69	12.94									Combine flow at DP C3 Outfall to ButcherKnife Creek
C4	C4		6.57	0.42	13.6	2.79	2.23	6.24													Direct runoff to DP C4ButcherKnife Creek
Sub-basin D																					
D1	D1		4.89	0.43	12.6	2.08	2.31	4.81													Direct runoff at DP D1 Outfall to ButcherKnife Creek
Sub-basin E																					
E1	E1		3.23	0.46	12.6	1.49	2.31	3.43							3.43	1.0	18	55.0	5.9	0.2	Direct runoff at DP E1 Pipe Flow to DP E2
E2	E2		1.59	0.46	6.8	0.73	2.92	2.13													Direct runoff at DP E2
	E2		4.82	0.46					12.7	2.22	2.30	5.10									Combine Flow at DP E2 Outfall to ButcherKnife Creek

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	0.78			DESIGN STORM:	**10-YEAR**
10-year P1 =	**0.94**	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	1.09	CHECKED BY: KSC	MAJOR BASIN: Butcherknife Creek and Portions of DFA - Yampa	LOCATION:	Butcherknife Creek and Portions of DFA - Yampa
100-year P1 =	1.46				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Sub-basin F																					
F1	F1		3.52	0.66	7.4	2.33	2.84	6.63							6.63	1.0	18	441.0	5.9	1.2	Direct runoff at DP F1 Pipe Flow to DP F3
F2	F2		0.78	0.92	5.0	0.72	3.19	2.29							2.29	1.0	18	55.0	5.9	0.2	Direct runoff at DP F2 Pipe Flow to DP F3
F3	F3		3.38	0.69	6.2	2.32	3.00	6.96													Direct runoff at DP F3
	F3	F1, F2, & F3	7.68	0.70					8.6	5.37	2.69	14.45			14.45	1.0	36	220.0	9.1	0.4	Combine Flow at DP F3 Pipe Flow to DP F4
F4	F4		3.48	0.84	5.0	2.93	3.19	9.33													Direct runoff at DP F4
	F4	F1, F2, F3 & F4	11.16	0.74					9.0	8.29	2.65	21.96									Combine Flow at DP F4 Pipe outfall to ButcherKnife Creek
F5	F5		3.10	0.92	5.0	2.85	3.19	9.09							9.09	1.0	18	55.0	5.9	0.2	Direct runoff to DP C4ButcherKnife Creek
Sub-basin Y																					
Y20	Y20		2.07	0.92	5.2	1.90	3.15	6.00							6.00	1.0	12	395.0	4.6	1.4	Direct runoff at DP Y20 Pipe Flow to DP Y22
Y21	Y21		1.26	0.92	5.0	1.16	3.19	3.70							3.70	1.0	12	70.0	4.6	0.3	Direct runoff at DP Y21 Pipe Flow to DP Y26
Y22	Y22		3.26	0.92	5.1	3.00	3.18	9.52													Direct runoff at DP Y22 Direct Discharge to Yampa River
	Y22	Y20 & Y22	5.33	0.90					6.7	4.80	2.93	14.07									Combine Flow at DP Y22
Y23b	Y23b		7.85	0.43	12.4	3.41	2.33	7.94					4.2	7.94				550.0	4.1	2.2	Direct runoff at DP Y23b Curb flow to DP Y23a
Y23a	Y23a		4.59	0.44	10.2	2.02	2.52	5.09													Direct runoff at DP Y23a
	Y23a	Y23a and Y23b	12.44	0.44					14.6	5.43	2.16	11.73			11.73	3.0	18	330.0	10.7	0.5	Combine runoff to DP Y23a Pipe Flow to DP Y23
Y23	Y23		3.14	0.46	7.4	1.44	2.83	4.09													Direct Runoff at DP Y23
	Y23	Y23, Y23a and Y23b	15.58	0.44					15.1	6.88	2.12	14.61			14.61	3.0	18	380.0	10.7	0.6	Combine runoff to DP Y23a Pipe Flow to DP Y26
Y24	Y24		1.00	0.40	6.8	0.40	2.91	1.17													Direct Runoff at DP Y24
Y25	Y25		0.32	0.90	5.0	0.29	3.19	0.92							0.92	1.0	12	50.0	4.6	0.2	Direct Runoff at DP Y25 Pipe Flow to DP Y28
	Y24	Y24 & Y25	1.32	0.52					6.8	0.69	2.91	2.00			2.00	2.1	18	380.0	8.8	0.7	Pipe Flow to DP Y27
Y26	Y26		3.41	0.90	5.0	3.07	3.19	9.79													Direct Runoff at DP Y26
	Y26	Y21, Y23 & Y26	20.25	0.55					15.7	11.11	2.09	23.16			23.16	3.1	18	380.0	10.9	0.6	Combine Flow at DP Y26 Pipe Flow to DP Y27
Y27	Y27		3.32	0.90	5.0	2.99	3.19	9.53													Direct Flow at DP Y27
	Y27	Y21, Y23, Y26 & Y27	23.57	0.60					16.3	14.09	2.05	28.88									Combine Flow at DP Y27 Direct Discharge to Yampa River
Y28	Y28		1.68	0.90	5.0	1.51	3.19	4.82													Direct Runoff at DP Y28
	Y28	Y24, Y25 & Y28	3.00	0.73					7.5	2.20	2.82	6.20			6.20	2.4	18	210.0	9.5	0.4	Combine Flow at DP Y28 Pipe Flow to DP Y29
Y29	Y29		1.79	0.90	5.0	1.61	3.19	5.14													Direct Runoff at DP Y29
	Y29	Y24, Y25, Y28 & Y29	4.79	0.80					7.9	3.81	2.77	10.57			10.57	5.9	18	170.0	15.4	0.2	Combine Flow at DP Y29 Pipe Flow to DP Y30
Y30	Y30		1.37	0.90	5.0	1.23	3.19	3.93													Direct Runoff to DP Y30 Combine Flow at DP Y30
	Y30	Y24, Y25, Y28, Y29 & Y30	6.16	0.82					8.1	5.04	2.75	13.88									Direct Discharge to Yampa River

Notes: Intensity -Duration Curve for Rational Method per equation RA-3 (Urban Drainage)
I = (28.5*P1) / (10+Tc)^.786

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	0.78			DESIGN STORM:	**25-YEAR**
10-year P1 =	0.94	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	**1.09**	CHECKED BY: KSC	MAJOR BASIN: Butcherknife Creek and Portions of DFA - Yampa	LOCATION:	City of Steamboat Springs, Colorado
100-year P1 =	1.46				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Sub-basin A																					
A1	A1		5.92	0.43	5.3	2.54	3.63	9.22													Direct runoff to DP A1 & ButcherKnife Creek
A2	A2		5.53	0.48	5.0	2.65	3.70	9.78													Direct Runoff to DP A2 & ButcherKnife Creek
A3	A3		3.08	0.47	5.0	1.45	3.70	5.37													Direct Runoff to DP A3 & ButcherKnife Creek
A4	A4		2.42	0.50	12.4	1.22	2.70	3.29													Direct Runoff to DP A4 & ButcherKnife Creek
Sub-basin B																					
B1	B1		2.95	0.45	5.0	1.32	3.70	4.90													Direct runoff to DP B1 & ButcherKnife Creek
B2	B2		4.06	0.53	14.6	2.15	2.50	5.38													Direct runoff to DP B2 & ButcherKnife Creek
B3	B3		3.93	0.51	13.4	2.00	2.61	5.23													Direct runoff to DP B3 & ButcherKnife Creek
Sub-basin C																					
C1	C1		5.67	0.51	17.8	2.89	2.28	6.59					1.5	6.59				286.0	2.4	1.9	Direct runoff to DP C1 Ditch flow to DP C2
C2	C2		6.48	0.53	15.0	3.43	2.48	8.51													Direct runoff to DP C2
	C2	C1 & C2	12.15	0.52					19.7	6.33	2.16	13.67	1.5	13.67				560.0	2.4	3.8	Combine flow at DP C2 Ditch flow to DP C3
C3	C3		4.69	0.53	14.1	2.49	2.54	6.32													Direct runoff to DP C3
	C3	C1, C2 & C3	16.84	0.52					23.5	8.81	1.97	17.32									Combine flow at DP C3 Outfall to ButcherKnife Creek
C4	C4		6.57	0.50	13.6	3.30	2.59	8.55													Direct runoff to DP C4ButcherKnife Creek
Sub-basin D																					
D1	D1		4.89	0.50	12.6	2.44	2.68	6.54													Direct runoff at DP D1
Sub-basin E																					
E1	E1		3.23	0.53	12.6	1.71	2.68	4.59							4.59	1.0	18	55.0	5.9	0.2	Direct runoff at DP E1 Pipe Flow to DP E2
E2	E2		1.59	0.53	6.8	0.84	3.38	2.85													Direct runoff at DP E2
	E2		4.82	0.53					12.7	2.55	2.67	6.81									Combine Flow at DP E2 Pipe outfall to ButcherKnife Creek

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	0.78			DESIGN STORM:	**25-YEAR**
10-year P1 =	0.94	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	**1.09**	CHECKED BY: KSC	MAJOR BASIN: Butcherknife Creek and Portions of DFA - Yampa	LOCATION:	City of Steamboat Springs, Colorado
100-year P1 =	1.46				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Sub-basin F																					
F1	F1		3.52	0.71	7.4	2.50	3.30	8.24							8.24	1.0	18	441.0	5.9	1.2	Direct runoff at DP F1 Pipe Flow to DP F3
F2	F2		0.78	0.94	5.0	0.73	3.70	2.71							2.71	1.0	18	55.0	5.9	0.2	Direct runoff at DP F2 Pipe Flow to DP F3
F3	F3		3.38	0.73	6.2	2.47	3.48	8.60													Direct runoff at DP F3
	F3	F1, F2, & F3	7.68	0.74					8.6	5.70	3.12	17.80			17.80	1.0	36	220.0	9.1	0.4	Combine Flow at DP F3 Pipe Flow to DP F4
F4	F4		3.48	0.87	5.0	3.03	3.70	11.22													Direct runoff at DP F4
	F4	F1, F2, F3 & F4	11.16	0.78					9.0	8.74	3.07	26.82									Combine Flow at DP F4 Pipe outfall to ButcherKnife Creek
F5	F5		3.10	0.94	5.0	2.91	3.70	10.77							10.77	1.0	18	55.0	5.9	0.2	Direct runoff to DP C4ButcherKnife Creek
Sub-basin Y																					
Y20	Y20		2.07	0.94	5.2	1.95	3.65	7.10							7.10	1.0	12	395.0	4.6	1.4	Direct runoff at DP Y20 Pipe Flow to DP Y22
Y21	Y21		1.26	0.94	5.0	1.18	3.70	4.38							4.38	1.0	12	70.0	4.6	0.3	Direct runoff at DP Y21 Pipe Flow to DP Y26
Y22	Y22		3.26	0.94	5.1	3.06	3.68	11.28													Direct runoff at DP Y22
	Y22	Y20 & Y22	5.33	0.90					6.7	4.80	3.40	16.31									Combine Flow at DP Y22 Direct Discharge to Yampa River
Y23b	Y23b		7.85	0.51	12.4	3.98	2.70	10.75					4.2	10.75				550.0	4.1	2.2	Direct runoff at DP Y23b Curb flow to DP Y23a
Y23a	Y23a		4.59	0.51	10.2	2.34	2.93	6.85													Direct runoff at DP D2
	Y23a	Y23a and Y23b	12.44	0.51					14.6	6.32	2.50	15.83			15.83	3.0	18	330.0	10.7	0.5	Combine runoff to DP D2 Pipe flow to DP Y23
Y23	Y23		3.14	0.53	7.4	1.66	3.28	5.46													Direct Runoff at DP Y23
	Y23	Y23a and Y23b	15.58	0.51					15.1	7.99	2.46	19.68			19.68	3.0	18	380.0	10.7	0.6	Combine runoff to DP D2 Pipe Flow to DP Y26
Y24	Y24		1.00	0.40	6.8	0.40	3.38	1.35													Direct Runoff at DP Y24
Y25	Y25		0.32	0.90	5.0	0.29	3.70	1.06							1.06	1.0	12	50.0	4.6	0.2	Direct Runoff at DP Y25 Pipe Flow to DP Y28
	Y24	Y24 & Y25	1.32	0.52					6.8	0.69	3.38	2.32			2.32	2.1	18	380.0	8.8	0.7	Pipe Flow to DP Y27
Y26	Y26		3.41	0.90	5.0	3.07	3.70	11.35													Direct Runoff at DP Y26
	Y26	Y21, Y23 & Y26	20.25	0.60					15.7	12.24	2.42	29.61			29.61	3.1	18	380.0	10.9	0.6	Combine Flow at DP Y26 Pipe Flow to DP Y27
Y27	Y27		3.32	0.90	5.0	2.99	3.70	11.05													Direct Flow at DP Y27
	Y27	Y21, Y23, Y26 & Y27	23.57	0.65					16.3	15.23	2.38	36.19									Combine Flow at DP Y27 Direct Discharge to Yampa River
Y28	Y28		1.68	0.90	5.0	1.51	3.70	5.59													Direct Runoff at DP Y28
	Y28	Y24, Y25 & Y28	3.00	0.73					7.5	2.20	3.27	7.19			7.19	2.4	18	210.0	9.5	0.4	Combine Flow at DP Y28 Pipe Flow to DP Y29
Y29	Y29		1.79	0.90	5.0	1.61	3.70	5.96													Direct Runoff at DP Y29
	Y29	Y24, Y25, Y28 & Y29	4.79	0.80					7.9	3.81	3.22	12.26			12.26	5.9	18	170.0	15.4	0.2	Combine Flow at DP Y29 Pipe Flow to DP Y30
Y30	Y30		1.37	0.90	5.0	1.23	3.70	4.56													Direct Runoff to DP Y30
	Y30	Y24, Y25, Y28, Y29 & Y30	6.16	0.82					8.1	5.04	3.19	16.09									Combine Flow at DP Y30 Direct Discharge to Yampa River

Notes: Intensity -Duration Curve for Rational Method per equation RA-3 (Urban Drainage)
I = (28.5*P1) / (10+Tc)^.786

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	0.78			DESIGN STORM:	**100-YEAR (minor storm)**
10-year P1 =	0.94	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	1.09	CHECKED BY: KSC	MAJOR BASIN: Butcherknife Creek and Portions of DFA - Yampa	LOCATION:	City of Steamboat Springs, Colorado
100-year P1 =	**1.46**				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Sub-basin A																					
A1	A1		5.92	0.54	5.3	3.20	4.86	15.59													Direct runoff to DP A1 & ButcherKnife Creek
A2	A2		5.53	0.57	5.0	3.16	4.95	15.63													Direct Runoff to DP A2 & ButcherKnife Creek
A3	A3		3.08	0.57	5.0	1.74	4.95	8.64													Direct Runoff to DP A3 & ButcherKnife Creek
A4	A4		2.42	0.58	12.4	1.41	3.61	5.10													Direct Runoff to DP A4 & ButcherKnife Creek
Sub-basin B																					
B1	B1		2.95	0.55	5.0	1.63	4.95	8.09													Direct runoff to DP B1 & ButcherKnife Creek
B2	B2		4.06	0.60	14.6	2.44	3.35	8.17													Direct runoff to DP B2 & ButcherKnife Creek
B3	B3		3.93	0.59	13.4	2.32	3.49	8.10													Direct runoff to DP B3 & ButcherKnife Creek
Sub-basin C																					
C1	C1		5.67	0.59	17.8	3.35	3.05	10.21					1.5	10.21				286.0	2.4	1.9	Direct runoff to DP C1 Ditch flow to DP C2
C2	C2		6.48	0.60	15.0	3.89	3.32	12.90													Direct runoff to DP C2
	C2	C1 & C2	12.15	0.60					19.7	7.23	2.89	20.94	1.5	20.94				560.0	2.4	3.8	Combine flow at DP C2 Ditch flow to DP C3
C3	C3		4.69	0.60	14.1	2.81	3.41	9.59													Direct runoff to DP C3
	C3	C1, C2 & C3	16.84	0.60					23.5	10.05	2.63	26.45									Combine flow at DP C3 Outfall to ButcherKnife Creek
C4	C4		6.57	0.58	13.6	3.83	3.47	13.28													Direct runoff to DP C4ButcherKnife Creek
Sub-basin D																					
D1	D1		4.89	0.58	12.6	2.85	3.59	10.24													Direct runoff at DP D1
Sub-basin E																					
E1	E1		3.23	0.60	12.6	1.94	3.59	6.96							6.96	1.0	18	55.0	5.9	0.2	Direct runoff at DP E1 Pipe Flow to DP E2
E2	E2		1.59	0.60	6.8	0.95	4.53	4.32													Direct runoff at DP E2
	E2		4.82	0.60					12.7	2.89	3.57	10.32									Combine Flow at DP E2 Pipe Outfall to Butcherknife Creek

STANDARD FORM SF-2
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

5-year P1 =	0.78			DESIGN STORM:	**100-YEAR (minor storm)**
10-year P1 =	0.94	CALCULATED BY: JDM	PROJECT: Old Town Drainage Study	JOB NO:	50500101
25-year P1 =	1.09	CHECKED BY: KSC	MAJOR BASIN: Butcherknife Creek and Portions of DFA - Yampa	LOCATION:	City of Steamboat Springs, Colorado
100-year P1 =	**1.46**				

		DIRECT RUNOFF							TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			
LOCATION	DESIGN POINT	AREA DESIG.	AREA (Acres)	RUNOFF COEFF	Tc (min)	C A (Acres)	I (in/hour)	Q (cfs)	Tc (min)	(C A) (Acres)	I (in/hour)	Q (cfs)	SLOPE (%)	STREET FLOW (cfs)	DESIGN FLOW (cfs)	SLOPE (%)	PIPE SIZE	LENGTH (ft)	VELOCITY (fps)	Tt (min)	REMARKS
Sub-basin F																					
F1	F1		3.52	0.76	7.4	2.67	4.41	11.79							11.79	1.0	18	441.0	5.9	1.2	Direct runoff at DP F1 Pipe Flow to DP F3
F2	F2		0.78	0.96	5.0	0.75	4.95	3.71							3.71	1.0	18	55.0	5.9	0.2	Direct runoff at DP F2 Pipe Flow to DP F3
F3	F3		3.38	0.78	6.2	2.63	4.67	12.29													Direct runoff at DP F3
	F3	F1, F2, & F3	7.68	0.79					8.6	6.05	4.18	25.31			25.31	1.0	36	220.0	9.1	0.4	Combine Flow at DP F3 Pipe Flow to DP F4
F4	F4		3.48	0.91	5.0	3.15	4.95	15.61													Direct runoff at DP F4
	F4	F1, F2, F3 & F4	11.16	0.82					9.0	9.20	4.11	37.85									Combine Flow at DP F4 Pipe outfall to ButcherKnife Creek
F5	F5		3.10	0.96	5.0	2.98	4.95	14.74							14.74	1.0	18	55.0	5.9	0.2	Direct runoff to DP C4ButcherKnife Creek
Sub-basin Y																					
Y20	Y20		2.07	0.96	5.2	1.99	4.89	9.72							9.72	1.0	12	395.0	4.6	1.4	Direct runoff at DP Y20 Pipe Flow to DP Y22
Y21	Y21		1.26	0.96	5.0	1.21	4.95	5.99							5.99	1.0	12	70.0	4.6	0.3	Direct runoff at DP Y21 Pipe Flow to DP Y26
Y22	Y22		3.26	0.96	5.1	3.13	4.93	15.44													Direct runoff at DP Y22
	Y22	Y20 & Y22	5.33	0.90					6.7	4.80	4.56	21.85									Combine Flow at DP Y22 Direct Discharge to Yampa River
Y23b	Y23b		7.85	0.59	12.4	4.61	3.61	16.66					4.2	16.66				550.0	4.1	2.2	Direct runoff at DP Y23b Curb flow to DP Y23a
Y23a	Y23a		4.59	0.59	10.2	2.71	3.92	10.61													Direct runoff at DP Y23a
	Y23a	Y23a and Y23b	12.44	0.59					14.6	7.32	3.35	24.54			24.54	3.0	18	330.0	10.7	0.5	Combine runoff to DP Y23a Pipe flow to DP Y23
Y23	Y23		3.14	0.60	7.4	1.88	4.40	8.29													Direct Runoff at DP Y23
	Y23	Y23, Y23a and Y23b	15.58	0.59					15.1	9.20	3.30	30.36			30.36	3.0	18	380.0	10.7	0.6	Combine runoff to DP Y23 Pipe Flow to DP Y26
Y24	Y24		1.00	0.40	6.8	0.40	4.52	1.81													Direct Runoff at DP Y24
Y25	Y25		0.32	0.90	5.0	0.29	4.95	1.43							1.43	1.0	12	50.0	4.6	0.2	Direct Runoff at DP Y25 Pipe Flow to DP Y28
	Y24	Y24 & Y25	1.32	0.52					6.8	0.69	4.52	3.11			3.11	2.1	18	380.0	8.8	0.7	Pipe Flow to DP Y27
Y26	Y26		3.41	0.90	5.0	3.07	4.95	15.20													Direct Runoff at DP Y26
	Y26	Y21, Y23 & Y26	20.25	0.67					15.7	13.48	3.24	43.67			43.67	3.1	18	380.0	10.9	0.6	Combine Flow at DP Y26 Pipe Flow to DP Y27
Y27	Y27		3.32	0.90	5.0	2.99	4.95	14.80													Direct Flow at DP Y27
	Y27	Y21, Y23, Y26 & Y27	23.57	0.70					16.3	16.47	3.18	52.43									Combine Flow at DP Y27 Direct Discharge to Yampa River
Y28	Y28		1.68	0.90	5.0	1.51	4.95	7.49													Direct Runoff at DP Y28
	Y28	Y24, Y25 & Y28	3.00	0.73					7.5	2.20	4.38	9.63			9.63	2.4	18	210.0	9.5	0.4	Combine Flow at DP Y28 Pipe Flow to DP Y29
Y29	Y29		1.79	0.90	5.0	1.61	4.95	7.98													Direct Runoff at DP Y29
	Y29	Y24, Y25, Y28 & Y29	4.79	0.80					7.9	3.81	4.31	16.42			16.42	5.9	18	170.0	15.4	0.2	Combine Flow at DP Y29 Pipe Flow to DP Y30
Y30	Y30		1.37	0.90	5.0	1.23	4.95	6.11													Direct Runoff to DP Y30
	Y30	Y24, Y25, Y28, Y29 & Y30	6.16	0.82					8.1	5.04	4.27	21.55									Combine Flow at DP Y30 Direct Discharge to Yampa River

P:\Jobs\Steamboat Springs\Old Town Masterplan\MasterPlan\Drainage Calculations\3rd Submittal\[BK_Old-Town_Rational.xls]R100-Butcherknife Creek

J3 Engineering Consultants, Inc.

Notes: Intensity -Duration Curve for Rational Method per equation RA-3 (Urban Drainage)
I = (28.5*P1) / (10+Tc)^.786

Composite Imperviousness Calculations

Old Town Drainage Study

Soda Creek and Portions of DFA - Yampa

City of Steamboat Springs, Colorado

Job No.: 50500101
Date: 2/27/09
Calculated By: JDM
Checked By: KSC

Minor Sub-Basin	Example Block	Area (sq-ft)	Parcel Imperviousness: Street/Driveway/Alley 100	Parcel Imperviousness: Roof Tops 90	Parcel Imperviousness: Yard/Landscape Area 0	Composite Imperviousness (%)
Block 1	Lot 1	11062	2727	2110	6225	41.8
	Lot 2	10632	3037	2090	5505	46.3
	Lot 3	12695	4223	2897	5575	53.8
	Lot 4	16575	3059	1695	11821	27.7
	Lot 5	24999	2973	5874	16152	33.0
Block 1	**Sum**	**75963**	**16019**	**14666**	**45278**	38.5
Block 2	Lot 1	9295	2223	1305	5767	36.6
	Lot 2	8793	1933	1711	5149	39.5
	Lot 3	9418	2311	2348	4759	47.0
	Lot 4	8937	2524	3215	3198	60.6
Block 2	**Sum**	**36443**	**8991**	**8579**	**18873**	45.9
Block 3	Lot 1	6981	1549	3012	2420	61.0
	Lot 2	9045	1941	2021	5083	41.6
	Lot 3	9524	2411	2941	4172	53.1
	Lot 4	9656	2918	1606	5132	45.2
	Lot 5	9337	2117	2411	4809	45.9
Block 3	**Sum**	**44543**	**10936**	**11991**	**21616**	48.8

100 0 50 100 200

(IN FEET)
1 inch = 100 ft.

Project Number: 50500101	Drawn By: JDM
Designed By: JDM	Checked By: KSC
Issue Date: 07/16/2008	
Sheet Number: 07/16/2008	

OLD TOWN DRAINAGE STUDY
RESIDENTIAL RATIONAL CALCULATIONS
SAMPLE BLOCKS 1, 2 & 3

J3 Engineering Consultants Inc.
3151 S. Vaughn Way, Suite 680
Aurora, CO 80014
Tel: 303-368-5601 Fax: 303-368-5603
Email: Jmargraf@j3engineering.net
Contact: Jason Margraf, PE

100 0 50 100 200

(IN FEET)
1 inch = 100 ft.

Project Number: 50500101	Drawn By: JDM
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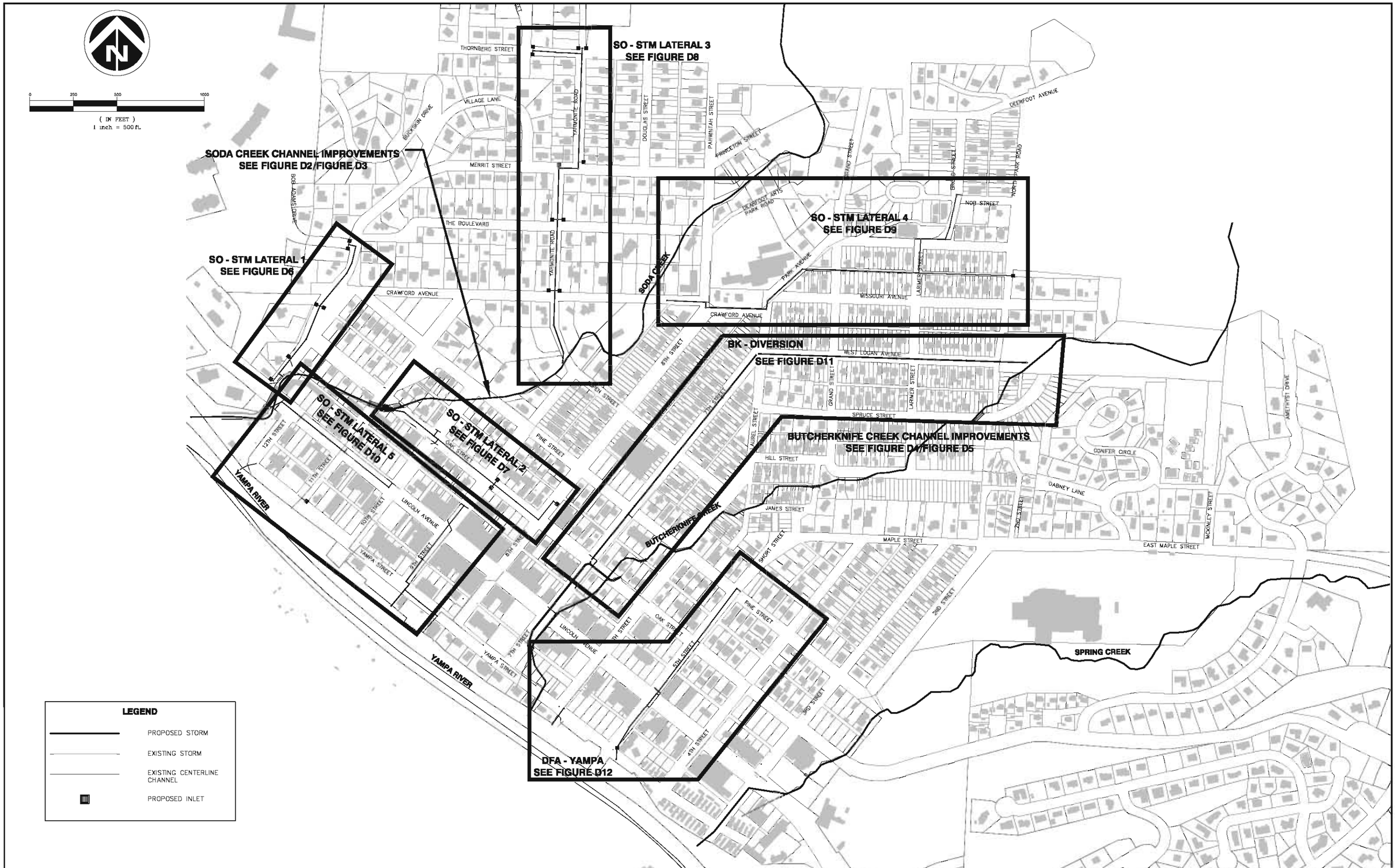
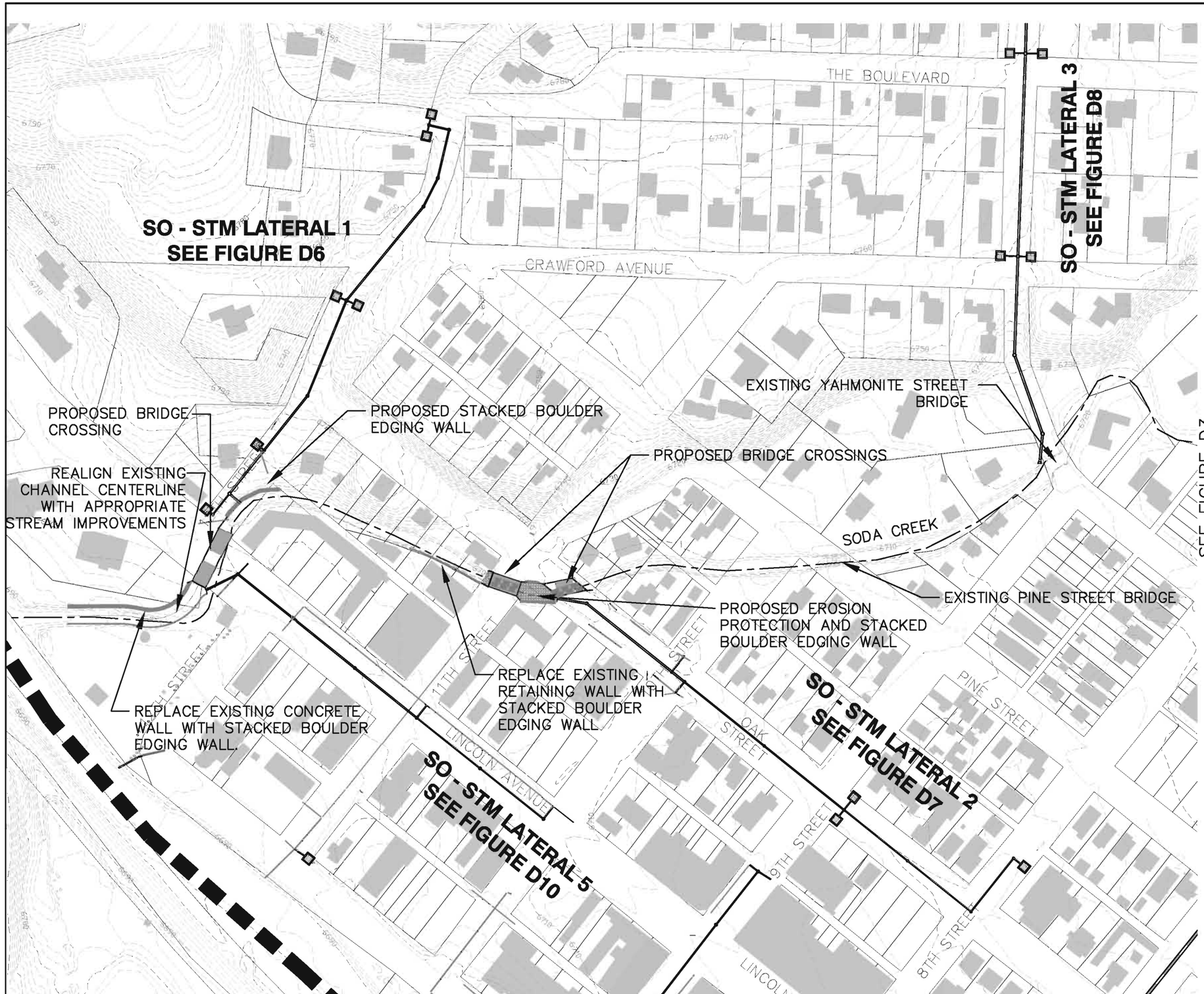
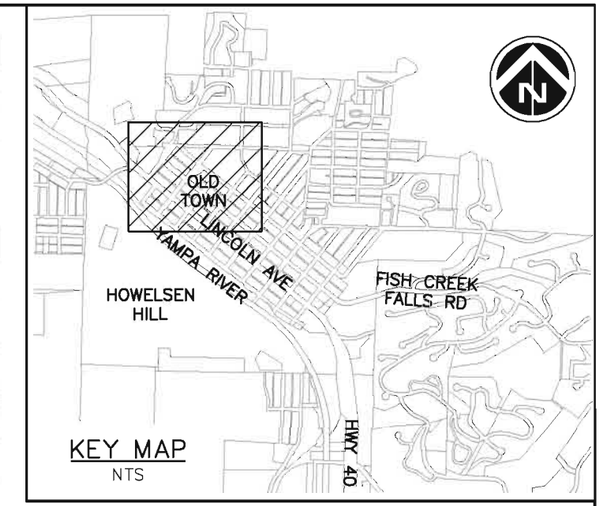
APPENDIX D:
STORM SEWER HYDRAULIC ANALYSIS AND SUPPORTING DOCUMENTATION



J3 Engineering Consultants Inc. 3151 S. Vaughn Way, Suite 680 Aurora, CO 80014 Tel: 303-368-5601 Fax: 303-368-5603	DESIGNED BY: JRD DRAWN BY: JAN CHECKED BY: KSC	DATE: 11/14/08 DATE: 02/28/09 DATE: 04/17/09	CITY OF STEAMBOAT SPRINGS	OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS	DRAINAGE IMPROVEMENTS ASSESSMENT, OVERALL MAP	FIGURE D1





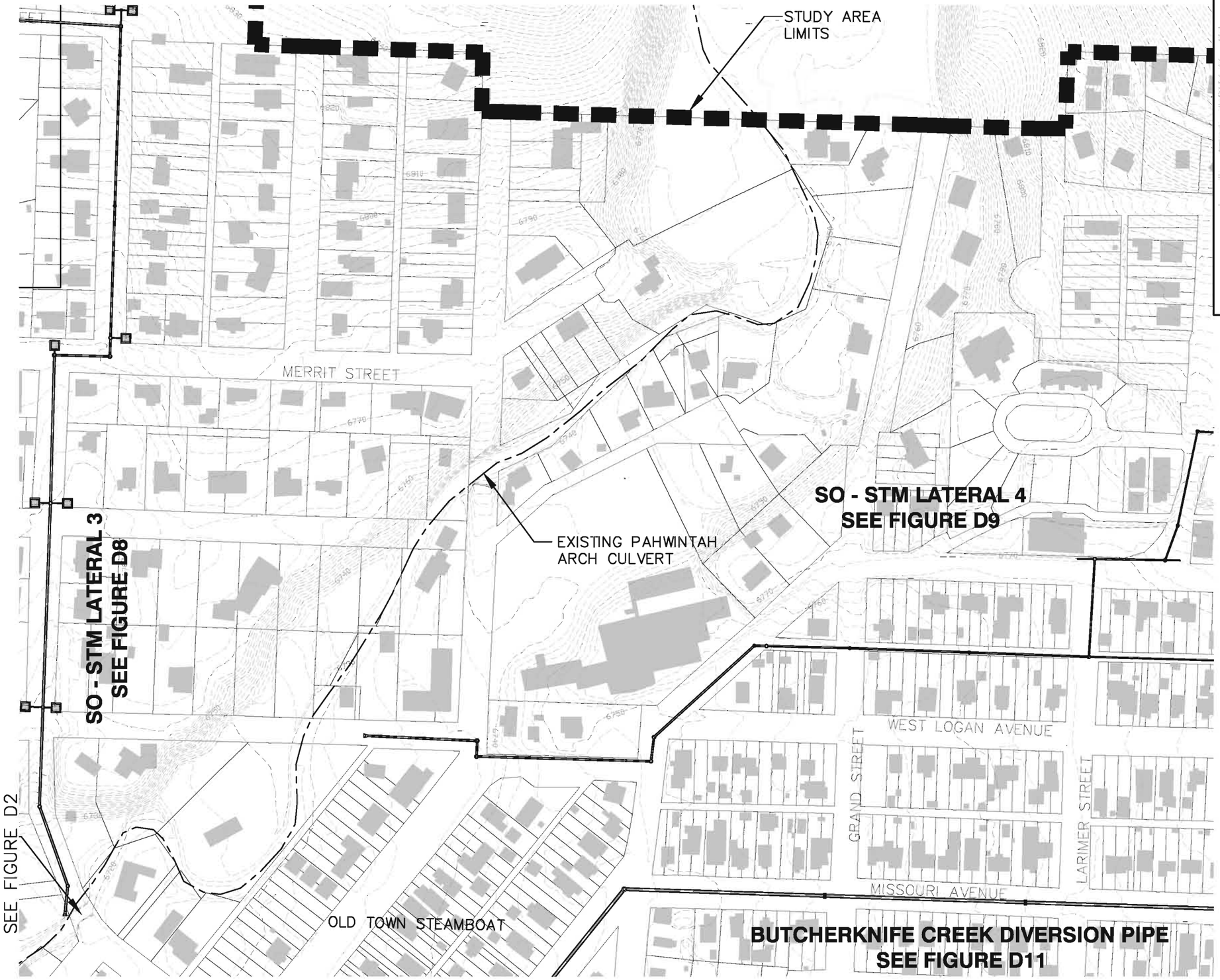
NOTES:

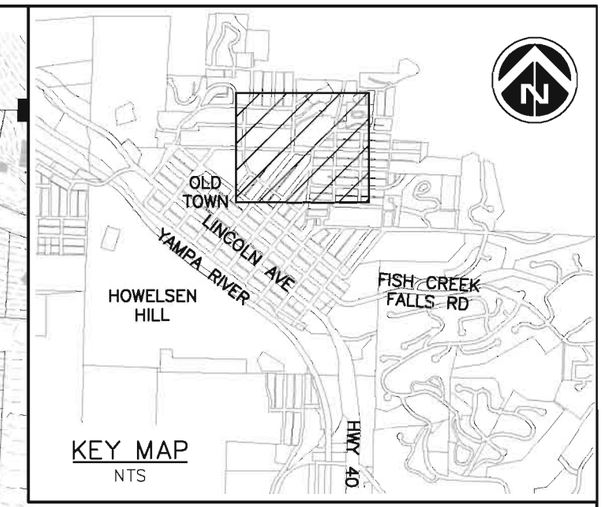
1. CHANNEL IMPROVEMENTS AND DESIGN RECOMMENDATIONS ARE PRELIMINARY IN NATURE. DETAILED TOPOGRAPHIC INFORMATION, DESIGN, AND HYDRAULIC ANALYSIS WITH A FINAL DRAINAGE REPORT ARE NECESSARY FOR FINAL IMPLEMENTATION.

0 100 200 400

(IN FEET)
1 inch = 200ft.

J3 Engineering Consultants Inc. 3151 S. Vaughn Way, Suite 680 Aurora, CO 80014 Tel: 303-368-5601 Fax: 303-368-5603	DESIGNED BY: JRD DATE: 11/14/08 DRAWN BY: JAN DATE: 02/28/09 CHECKED BY: KSC DATE: 04/17/09	CITY OF STEAMBOAT SPRINGS	OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS	SODA CREEK CHANNEL IMPROVEMENTS	FIGURE D2





NOTES:
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0 100 200 400

(IN FEET)
1 inch = 200ft.

J3 Engineering Consultants Inc. 3151 S. Vaughn Way, Suite 680 Aurora, CO 80014 Tel: 303-368-5601 Fax: 303-368-5603	DESIGNED BY: JRD DRAWN BY: JAN CHECKED BY: KSC	DATE: 11/14/08 DATE: 02/28/09 DATE: 04/17/09	CITY OF STEAMBOAT SPRINGS	OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS	SODA CREEK CHANNEL IMPROVEMENTS	FIGURE D3

COMMENTARY FIGURES D2 AND D3

SODA CREEK CHANNEL IMPROVEMENTS

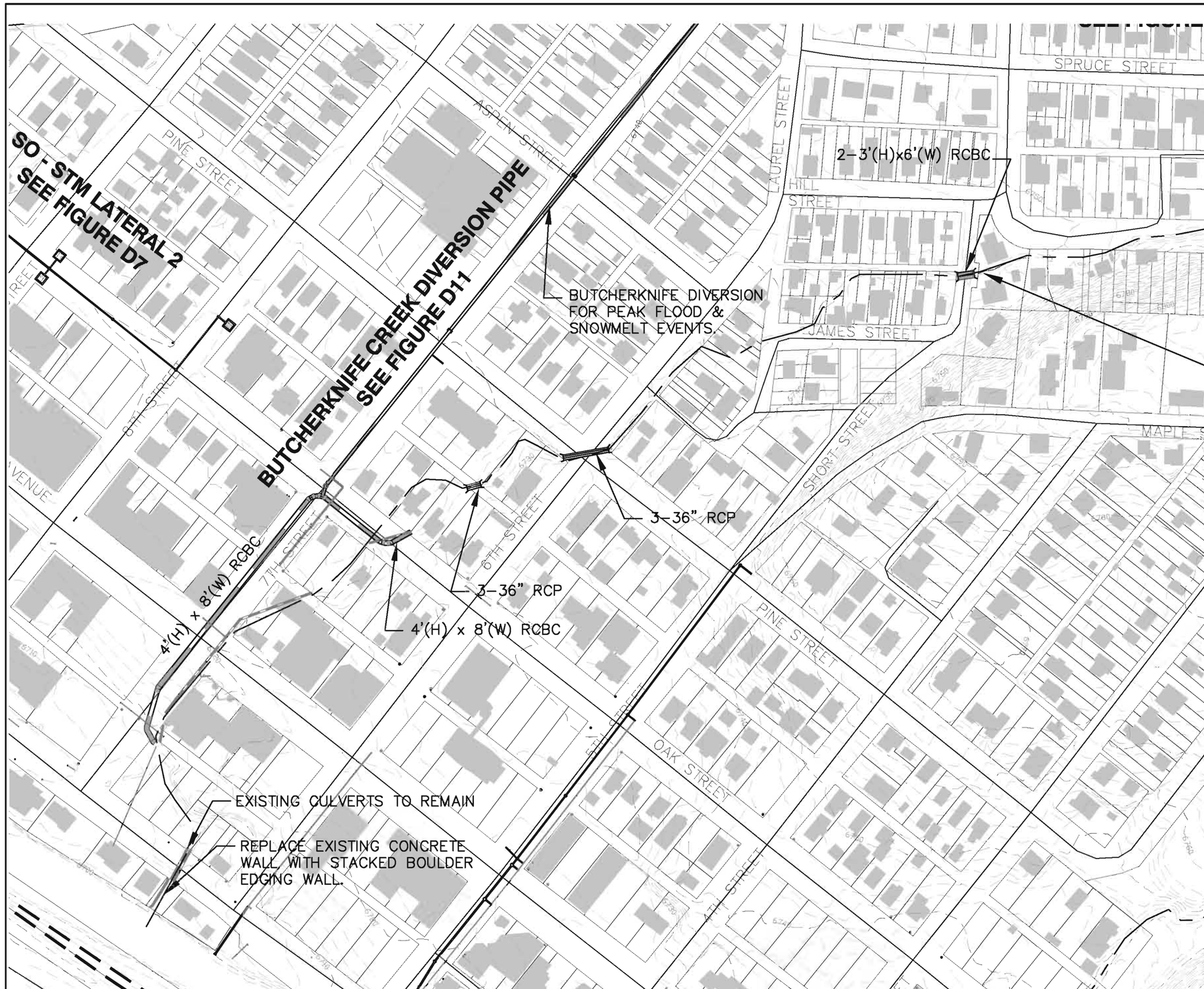
DESCRIPTION

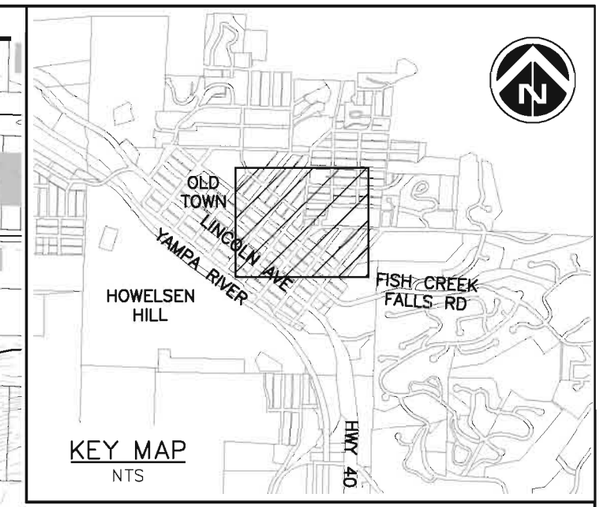
The Soda Creek channel improvements include stream restoration from the confluence of the Yampa River through Oak Street. The improvements include realigning the channel downstream of Lincoln Avenue for hydraulic efficiency and removing and replacing the existing deteriorated walls adjacent to the Warner Library and park. The improvements also include replacing the existing culvert under Lincoln Avenue with a conceptually sized 32-foot wide bridge crossing. The existing culverts located under 11th and Oak Street are also hydraulically undersized and would be replaced with 32-foot wide culverts or potentially an open-span bridge. Final design and hydraulic analysis of these crossings will ultimately determine the configuration and width of the structures. Ideally, the final design will include improvements to the culvert alignment, channel profile, entrance and exit conditions and channel stability to improve hydraulic performance and to optimize/minimize structure size. The open channel between the 11th Street and Oak Street culverts could likely be designed as one continuous culvert to reduce energy loses th

PRELIMINARY DESIGN COST ESTIMATE

Improvement	Quantity	Unit	Unit Cost	Total Cost
Channel Improvements	300	LF	$400.00	$120,000
32' (W) Bridge Crossing (Lincoln Avenue)	120	LF	$10,000.00	$1,200,000
32' (W) Culvert Crossing (11th and Oak Street)	125	LF	$7,500.00	$937,500
Grouted Boulder Stacked Wall Edge	985	LF	$125.00	$123,125
Channel Riprap Outlet Protection (Lincoln Avenue)	1	EA	$10,000.00	$10,000
Channel Riprap Outlet Protection (11th Street)	1	EA	$10,000.00	$10,000
Channel Riprap Outlet Protection (Oak Street)	1	EA	$20,000.00	$20,000

Total Estimated Construction Cost	$2,420,625
Utility Relocation (5% of Construction Cost)	$121,031
Engineering and Contingency (35% of Construction and Utility)	$889,580
TOTAL ESTIMATED COST	**$3,431,236**





MINOR CHANNEL IMPROVEMENTS MAY BE REQUIRED UPSTREAM OF THE PROPOSED CULVERT ALONG THE RIGHT BANK TO ELIMINATE BANK OVERTOPPING. THE HYDRAULIC MODEL ASSUMED AN ADDITIONAL SIX INCHES (AT A MINIMUM) OF FILL TO CONTAIN PEAK FLOOD FLOWS. THIS DOES NOT ACCOUNT FOR FREEBOARD. THE EXACT CONFIGURATION IS TO BE DETERMINED DURING FINAL DESIGN.

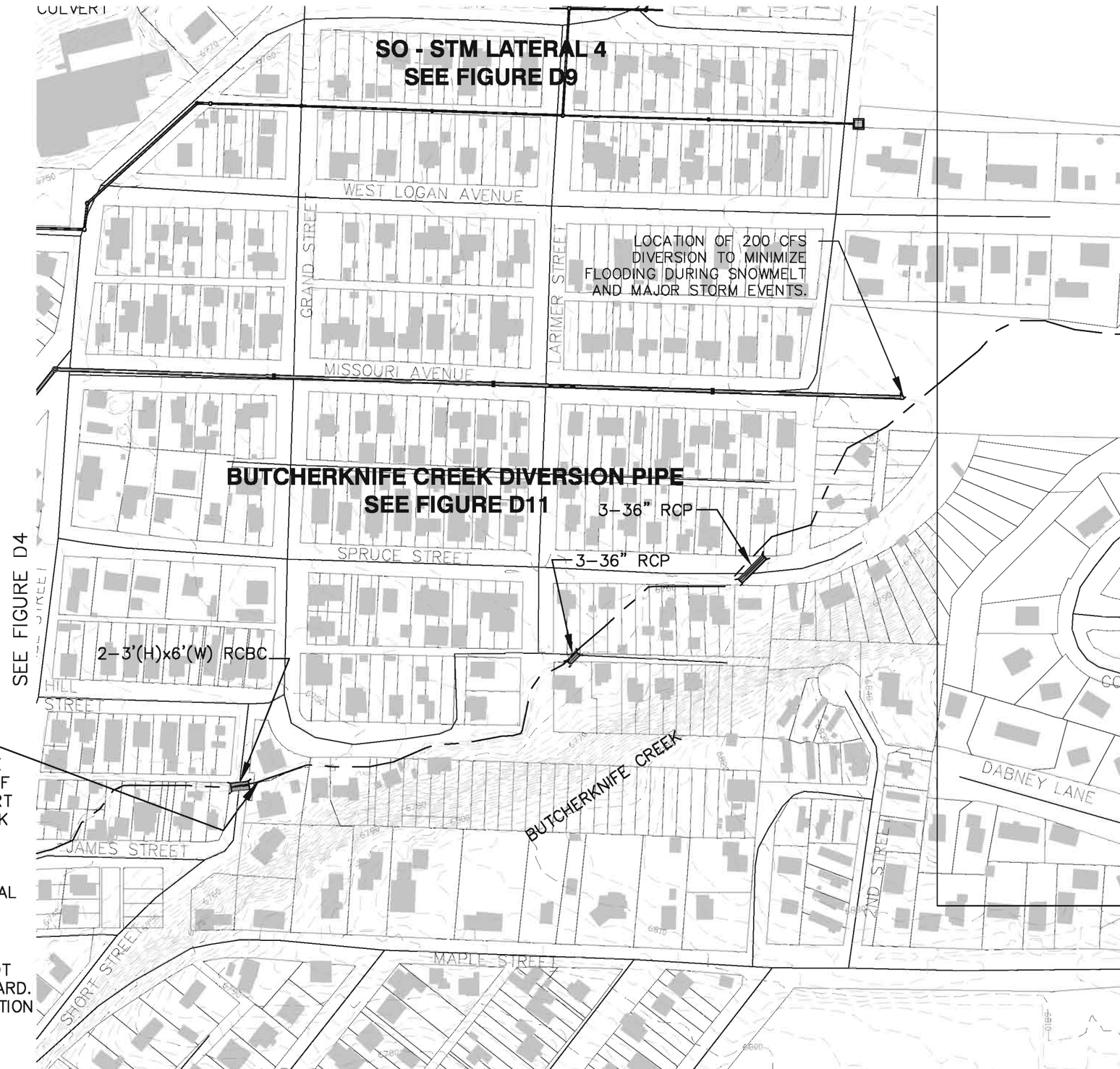
NOTES:

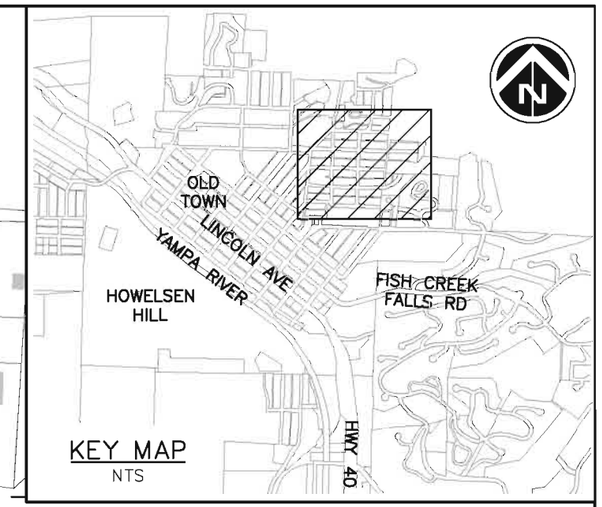
1. CHANNEL IMPROVEMENTS AND DESIGN RECOMMENDATIONS ARE PRELIMINARY IN NATURE. DETAILED TOPOGRAPHIC INFORMATION, DESIGN, AND HYDRAULIC ANALYSIS WITH A FINAL DRAINAGE REPORT ARE NECESSARY FOR FINAL IMPLEMENTATION.

0 100 200 400

(IN FEET)
1 inch = 200ft.

J3 Engineering Consultants Inc. 3151 S. Vaughn Way, Suite 680 Aurora, CO 80014 Tel: 303-368-5601 Fax: 303-368-5603	DESIGNED BY: JRD DRAWN BY: JAN CHECKED BY: KSC	DATE: 11/14/08 DATE: 02/28/09 DATE: 04/17/09	CITY OF STEAMBOAT SPRINGS	OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS	BUTCHERKNIFE CREEK CHANNEL IMPROVEMENTS	FIGURE D4





NOTES:

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0 100 200 400

(IN FEET)
1 inch = 200ft.

J3 Engineering Consultants Inc. 3151 S. Vaughn Way, Suite 680 Aurora, CO 80014 Tel: 303-368-5601 Fax: 303-368-5603	DESIGNED BY: JRD DATE: 11/14/08 DRAWN BY: JAN DATE: 02/28/09 CHECKED BY: KSC DATE: 04/17/09	CITY OF STEAMBOAT SPRINGS	OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS	BUTCHERKNIFE CREEK CHANNEL IMPROVEMENTS	FIGURE D5

COMMENTARY FIGURES D4 AND D5

BUTCHERKNIFE CREEK CHANNEL IMPROVEMENTS

DESCRIPTION

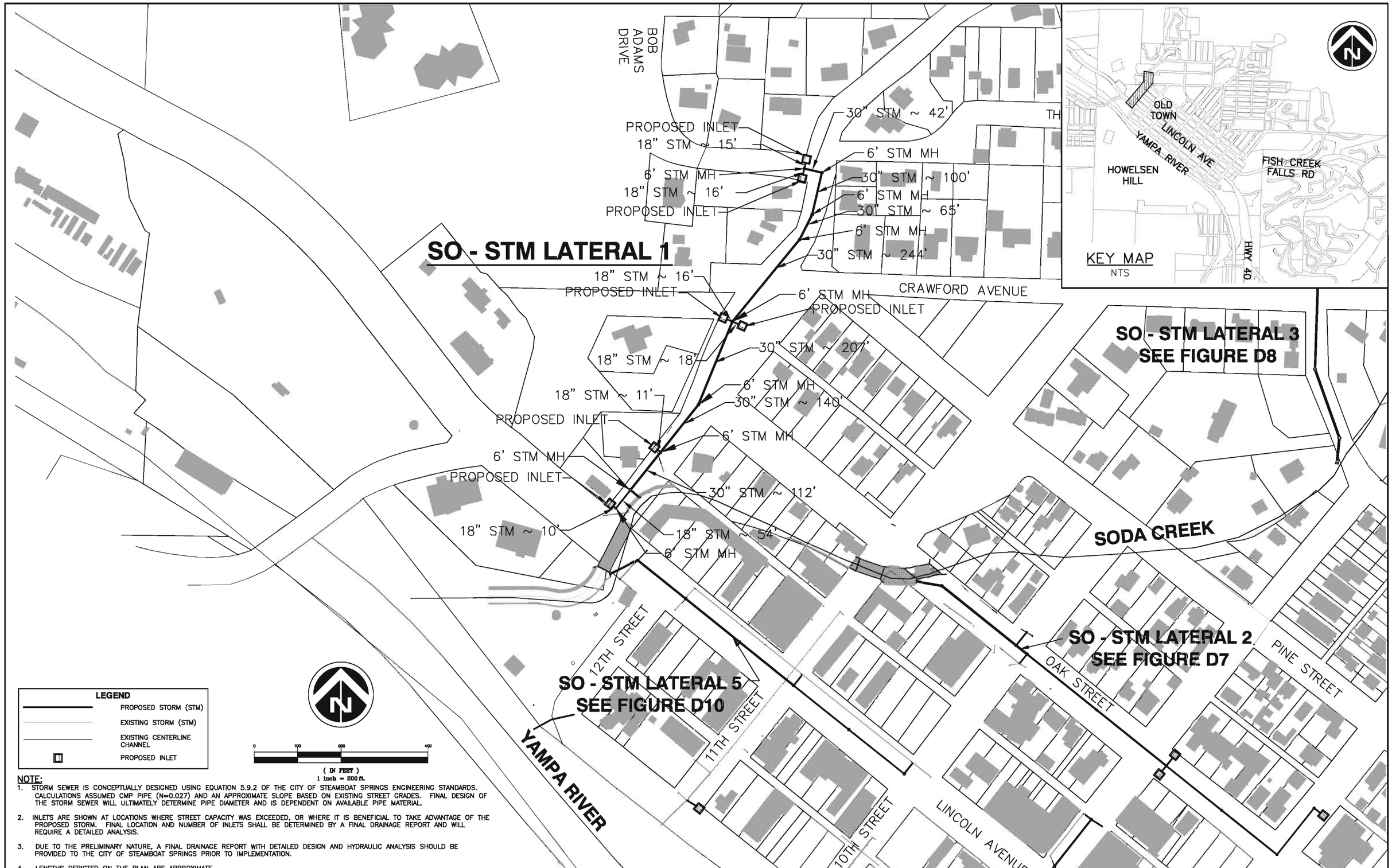
The Butcherknife Creek channel improvements includes the segment of stream from the diversion located at Stehley Park to the confluence with the Yampa River. The 100-year storm event documented in the 2005 FIS estimates the peak flow to be 325 cfs through the City of Steamboat Springs. The preliminary design and associated cost estimate assumes construction of the diversion pipe, which reduces the main channel flow by approximately 200 cfs. The costs associated with the diversion pipe are estimated in the commentary in Figure D11 and are not included with this sheet. Downstream of Oak Street, Butcherknife Creek is conveyed within a 4' (H) by 8' (W) RCBC. Upstream of Oak Street, the existing channel crossings are hydraulically inadequate and require improvements. Crossings under the alley between Oak Street and Pine Street, Pine Street, Butcherknife Alley and Spruce Street are estimated to comprise of 3-36" RCP. Due to limited head available and the channel not being able to convey the flow, the crossing under Short Street should comprise of 2 - 3' (H) by 6' (W) RCBC and some upstream channel improvements to increase hydraulic efficiency.

Note: 157 LF of this is currently designed and planned for construciton as part of a CDOT US-40 Highway Improvement Project. These costs are currently being refined as part of a cost sharing agreement between the City of Steamboat Springs and CDOT and so that quantity is within this estimate.

PRELIMINARY DESIGN COST ESTIMATE

Improvement	Quantity	Unit	Unit Cost	Total Cost
4' (H) by 8' (W) RCBC	795	LF	$725.00	$576,375
3' (H) by 6' (W) RCBC	70	LF	$475.00	$33,250
Precast 4' (H) by 8' (W) RCBC 22.5 Bends	11	EA	$2,500.00	$27,500
36" RCP	630	LF	$145.00	$91,350
Grouted Boulder Stacked Wall Edge	80	FF	$125.00	$10,000
Channel Riprap Outfall Protection	7	EA	$10,000.00	$70,000
Channel Improvements	150	LF	$400.00	$60,000

Total Estimated Construction Cost	$868,475
Utility Relocation (5% of Construction Cost)	$43,424
Engineering and Contingency (35% of Construction and Utility)	$319,165
TOTAL ESTIMATED COST	**$1,231,063**



NOTE:

1. STORM SEWER IS CONCEPTUALLY DESIGNED USING EQUATION 5.9.2 OF THE CITY OF STEAMBOAT SPRINGS ENGINEERING STANDARDS. CALCULATIONS ASSUMED CMP PIPE (N=0.027) AND AN APPROXIMATE SLOPE BASED ON EXISTING STREET GRADES. FINAL DESIGN OF THE STORM SEWER WILL ULTIMATELY DETERMINE PIPE DIAMETER AND IS DEPENDENT ON AVAILABLE PIPE MATERIAL.
2. INLETS ARE SHOWN AT LOCATIONS WHERE STREET CAPACITY WAS EXCEEDED, OR WHERE IT IS BENEFICIAL TO TAKE ADVANTAGE OF THE PROPOSED STORM. FINAL LOCATION AND NUMBER OF INLETS SHALL BE DETERMINED BY A FINAL DRAINAGE REPORT AND WILL REQUIRE A DETAILED ANALYSIS.
3. DUE TO THE PRELIMINARY NATURE, A FINAL DRAINAGE REPORT WITH DETAILED DESIGN AND HYDRAULIC ANALYSIS SHOULD BE PROVIDED TO THE CITY OF STEAMBOAT SPRINGS PRIOR TO IMPLEMENTATION.
4. LENGTHS DEPICTED ON THE PLAN ARE APPROXIMATE.

J3 Engineering Consultants Inc.
3151 S. Vaughn Way, Suite 680
Aurora, CO 80014
Tel: 303-368-5601 Fax: 303-368-5603

DESIGNED BY: JRD	DATE: 11/14/08	
DRAWN BY: JAN	DATE: 02/28/09	
CHECKED BY: KSC	DATE: 04/17/09	

CITY OF STEAMBOAT SPRINGS

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS

SODA CREEK STORM SEWER LATERAL 1

FIGURE D6

COMMENTARY FIGURE D6

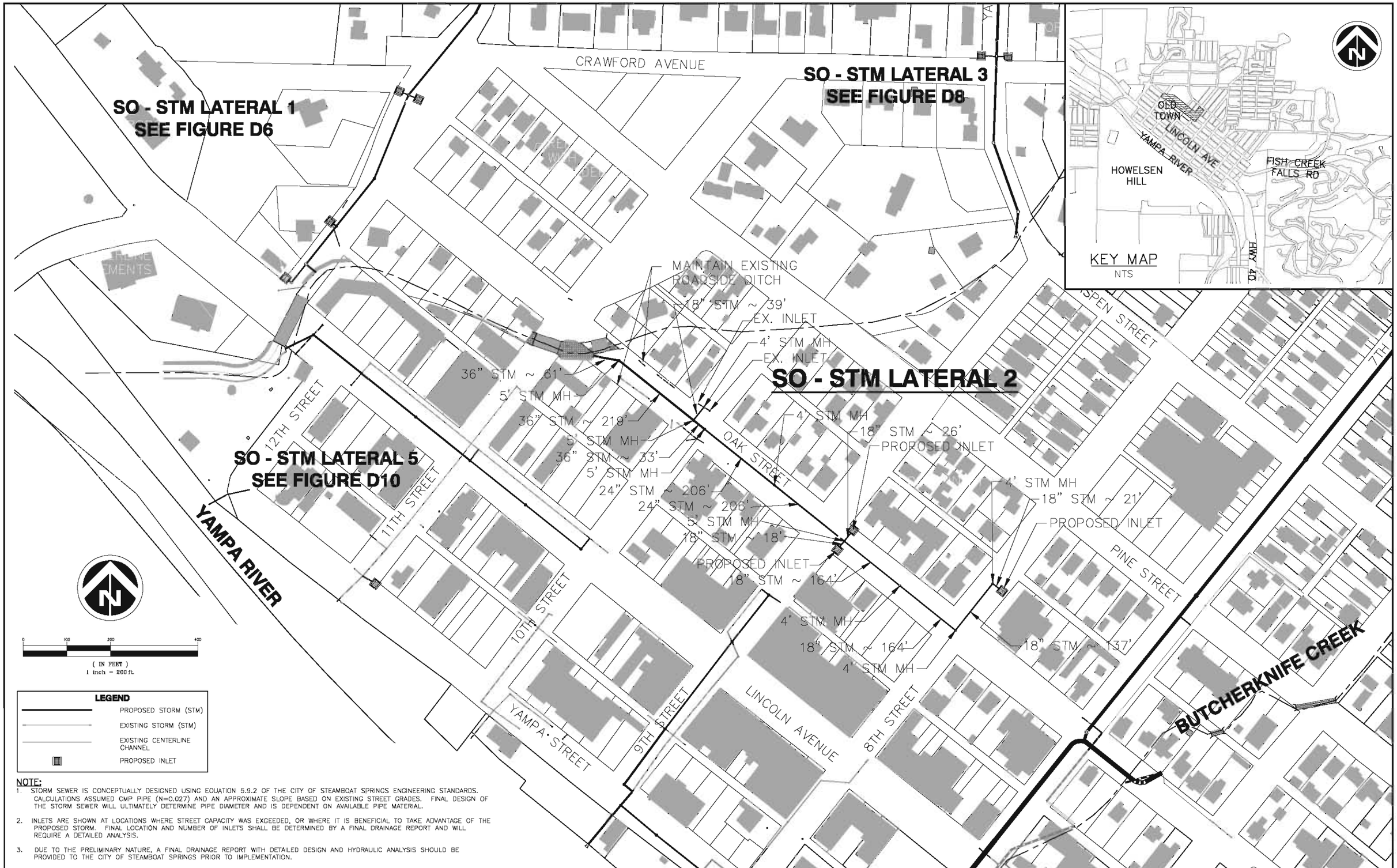
SO - STM LATERAL 1

DESCRIPTION

Street capacity is exceeded at the intersection of Bob Adams Drive and The Boulevard at Design Point SO-C3. Therefore, the storm sewer was extended to that intersection location for the necessary inlets. Inlets were added along the storm sewer lateral to capture additional surface flow to take advantage of the proposed storm sewer. Final design will need to determine final location of inlets and storm sewer and the number of inlets. SO - Storm Lateral 1 will discharge into Soda Creek upstream of the bridge / culvert located at Lincoln Avenue.

PRELIMINARY DESIGN COST ESTIMATE

Improvement	Quantity	Unit	Unit Cost	Total Cost
18" CMP	140	LF	$60.00	$8,400
30" CMP	935	LF	$110.00	$102,850
Inlets	6	EA	$5,000.00	$30,000
Manhole, 6' Diameter	2	EA	$3,400.00	$6,800
Manhole, 5' Diameter	6	EA	$2,500.00	$15,000
Manhole, 4' Diameter	1	EA	$2,150.00	$2,150
Riprap Outlet Protection	1	EA	$2,000.00	$2,000
Connection to Existing Infrastructure		EA	$3,000.00	$0
Total Estimated Construction Cost				$167,200
Utility Relocation (5% of Construction Cost)				$8,360
Engineering and Contingency (35% of Construction and Utility)				$61,446
TOTAL ESTIMATED COST				**$237,006**



NOTE:

1. STORM SEWER IS CONCEPTUALLY DESIGNED USING EQUATION 5.9.2 OF THE CITY OF STEAMBOAT SPRINGS ENGINEERING STANDARDS. CALCULATIONS ASSUMED CMP PIPE (N=0.027) AND AN APPROXIMATE SLOPE BASED ON EXISTING STREET GRADES. FINAL DESIGN OF THE STORM SEWER WILL ULTIMATELY DETERMINE PIPE DIAMETER AND IS DEPENDENT ON AVAILABLE PIPE MATERIAL.
2. INLETS ARE SHOWN AT LOCATIONS WHERE STREET CAPACITY WAS EXGEEDED, OR WHERE IT IS BENEFICIAL TO TAKE ADVANTAGE OF THE PROPOSED STORM. FINAL LOCATION AND NUMBER OF INLETS SHALL BE DETERMINED BY A FINAL DRAINAGE REPORT AND WILL REQUIRE A DETAILED ANALYSIS.
3. DUE TO THE PRELIMINARY NATURE, A FINAL DRAINAGE REPORT WITH DETAILED DESIGN AND HYDRAULIC ANALYSIS SHOULD BE PROVIDED TO THE CITY OF STEAMBOAT SPRINGS PRIOR TO IMPLEMENTATION.
4. LENGTHS DEPIGTED ON THE PLAN ARE APPROXIMATE.

J3 Engineering Consultants Inc.
3151 S. Vaughn Way, Suite 680
Aurora, CO 80014
Tel: 303-368-5601 Fax: 303-368-5603

DESIGNED BY: JRD	DATE: 11/14/08	
DRAWN BY: JAN	DATE: 02/28/09	
CHECKED BY: KSC	DATE: 04/17/09	

CITY OF STEAMBOAT SPRINGS

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS

SODA CREEK STORM SEWER LATERAL 2

FIGURE D7

COMMENTARY FIGURE D7

SO - STM LATERAL 2

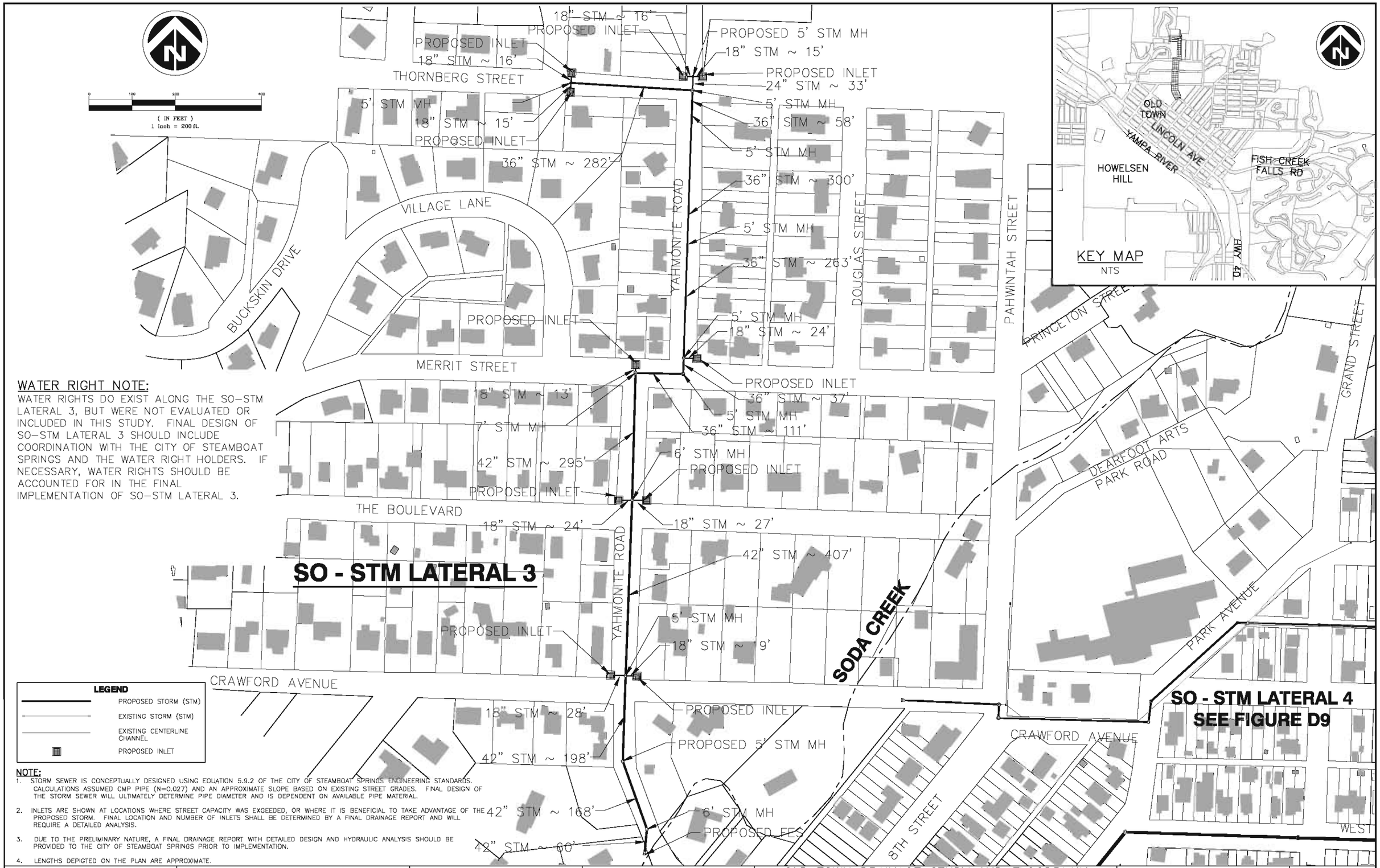
DESCRIPTION

Street capacity for the minor storm event is exceeded for the tributary area along Oak Street. SO - Lateral 2 extends from Soda Creek to 8th Street. The lateral was extended northeast along 8th Street to a proposed inlet near the church to capture and convey the surface discharge from a sump pump. Groundwater causes a nuisance surface flow that begins at this location and persisted along Oak Street to Soda Creek. Several existing inlets and roadside ditches are present along Oak Street. The existing inlets will be connected to the proposed line and it is recommended that the roadside ditches remain in place to convey snowmelt runoff and portions of the 100-year storm event.

Final design will need to determine final location of inlets and storm sewer and the number of inlets.

PRELIMINARY DESIGN COST ESTIMATE

Improvement	Quantity	Unit	Unit Cost	Total Cost
36" CMP	315	LF	$130.00	$40,950
24" CMP	410	LF	$88.00	$36,080
18" CMP	595	EA	$60.00	$35,700
Inlets	3	EA	$5,000.00	$15,000
Manhole, 5' Diameter	4	EA	$2,500.00	$10,000
Manhole, 4' Diameter	5	EA	$2,150.00	$10,750
Riprap Outlet Protection	1	EA	$2,000.00	$2,000
Connection to Existing Infrastructure	2	EA	$3,000.00	$6,000
Head Wall, Pipe Penetration	1	EA	$5,000.00	$5,000
Total Estimated Construction Cost				$161,480
Utility Relocation (5% of Construction Cost)				$8,074
Engineering and Contingency (35% of Construction and Utility)				$59,344
TOTAL ESTIMATED COST				**$228,898**



WATER RIGHT NOTE:

WATER RIGHTS DO EXIST ALONG THE SO-STM LATERAL 3, BUT WERE NOT EVALUATED OR INCLUDED IN THIS STUDY. FINAL DESIGN OF SO-STM LATERAL 3 SHOULD INCLUDE COORDINATION WITH THE CITY OF STEAMBOAT SPRINGS AND THE WATER RIGHT HOLDERS. IF NECESSARY, WATER RIGHTS SHOULD BE ACCOUNTED FOR IN THE FINAL IMPLEMENTATION OF SO-STM LATERAL 3.

NOTE:

1. STORM SEWER IS CONCEPTUALLY DESIGNED USING EQUATION 5.9.2 OF THE CITY OF STEAMBOAT SPRINGS ENGINEERING STANDARDS. CALCULATIONS ASSUMED CMP PIPE (N=0.027) AND AN APPROXIMATE SLOPE BASED ON EXISTING STREET GRADES. FINAL DESIGN OF THE STORM SEWER WILL ULTIMATELY DETERMINE PIPE DIAMETER AND IS DEPENDENT ON AVAILABLE PIPE MATERIAL.
2. INLETS ARE SHOWN AT LOCATIONS WHERE STREET CAPACITY WAS EXGEEDED, OR WHERE IT IS BENEFICIAL TO TAKE ADVANTAGE OF THE PROPOSED STORM. FINAL LOCATION AND NUMBER OF INLETS SHALL BE DETERMINED BY A FINAL DRAINAGE REPORT AND WILL REQUIRE A DETAILED ANALYSIS.
3. DUE TO THE PRELIMINARY NATURE, A FINAL DRAINAGE REPORT WITH DETAILED DESIGN AND HYDRAULIC ANALYSIS SHOULD BE PROVIDED TO THE CITY OF STEAMBOAT SPRINGS PRIOR TO IMPLEMENTATION.
4. LENGTHS DEPIGTED ON THE PLAN ARE APPROXIMATE.

J3 Engineering Consultants Inc.
3151 S. Vaughn Way, Suite 680
Aurora, CO 80014
Tel: 303-368-5601 Fax: 303-368-5603

DESIGNED BY: JRD	DATE: 11/14/08	
DRAWN BY: JAN	DATE: 02/28/09	
CHECKED BY: KSC	DATE: 04/17/09	

CITY OF STEAMBOAT SPRINGS

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS

SODA CREEK STORM SEWER LATERAL 3

FIGURE D8

COMMENTARY FIGURE D8

SO - STM LATERAL 3

DESCRIPTION

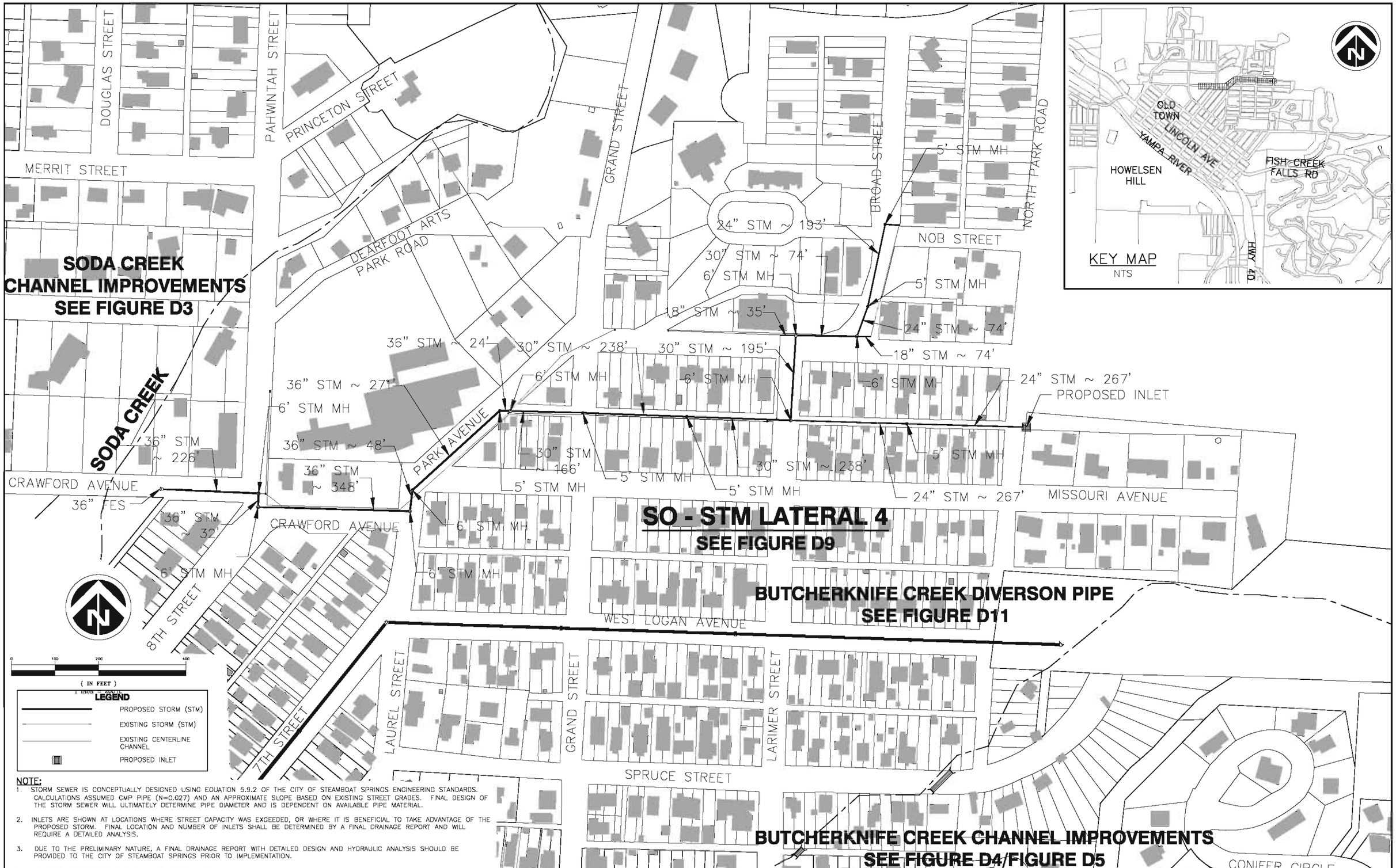
Street capacity is exceeded higher in this basin at the intersection of Thornberg Street and Uncochief Street at Design Point SO-B3. Therefore, storm sewer was extended to the location for necessary inlets. Several areas along Yahmonite Road were identified as problematic with localized flooding and nuisance flows. As a result, inlets were added along the storm sewer lateral to capture additional surface flow and help minimize the problematic nuisance flows. The existing roadside ditches are recommended to remain in place to convey the 100-year storm event. SO - Storm Lateral 3 will discharge into Soda Creek directly downstream of Yahmonite Bridge.

Final design will need to determine final location of inlets and storm sewer and the number of inlets.

PRELIMINARY DESIGN COST ESTIMATE

Improvement	Quantity	Unit	Unit Cost	Total Cost
42" RCP	1,120	LF	$160.00	$179,200
36" CMP	1,050	LF	$130.00	$136,500
18" CMP	225	EA	$60.00	$13,500
Inlets	10	EA	$5,000.00	$50,000
Manhole, 7' Diameter	3	EA	$5,000.00	$15,000
Manhole, 6' Diameter	5	EA	$3,400.00	$17,000
Manhole, 5' Diameter	3	EA	$2,500.00	$7,500
Manhole, 4' Diameter	1	EA	$2,150.00	$2,150
Riprap Outfall Protection	1	EA	$2,000.00	$2,000
42" FES	1	EA	$3,000.00	$3,000

Total Estimated Construction Cost	$246,650
Utility Relocation (5% of Construction Cost)	$12,333
Engineering and Contingency (35% of Construction and Utility)	$90,644
TOTAL ESTIMATED COST	**$349,626**



NOTE:

1. STORM SEWER IS CONCEPTUALLY DESIGNED USING EQUATION 5.9.2 OF THE CITY OF STEAMBOAT SPRINGS ENGINEERING STANDARDS. CALCULATIONS ASSUMED CMP PIPE (N=0.027) AND AN APPROXIMATE SLOPE BASED ON EXISTING STREET GRADES. FINAL DESIGN OF THE STORM SEWER WILL ULTIMATELY DETERMINE PIPE DIAMETER AND IS DEPENDENT ON AVAILABLE PIPE MATERIAL.
2. INLETS ARE SHOWN AT LOCATIONS WHERE STREET CAPACITY WAS EXGEEDED, OR WHERE IT IS BENEFICIAL TO TAKE ADVANTAGE OF THE PROPOSED STORM. FINAL LOCATION AND NUMBER OF INLETS SHALL BE DETERMINED BY A FINAL DRAINAGE REPORT AND WILL REQUIRE A DETAILED ANALYSIS.
3. DUE TO THE PRELIMINARY NATURE, A FINAL DRAINAGE REPORT WITH DETAILED DESIGN AND HYDRAULIC ANALYSIS SHOULD BE PROVIDED TO THE CITY OF STEAMBOAT SPRINGS PRIOR TO IMPLEMENTATION.
4. LENGTHS DEPIGTED ON THE PLAN ARE APPROXIMATE.

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CHECKED BY: KSC	DATE: 04/17/09	

CITY OF STEAMBOAT SPRINGS

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS

SODA CREEK STORM SEWER LATERAL 4

FIGURE D9

COMMENTARY FIGURE D9

SO - STM LATERAL 4

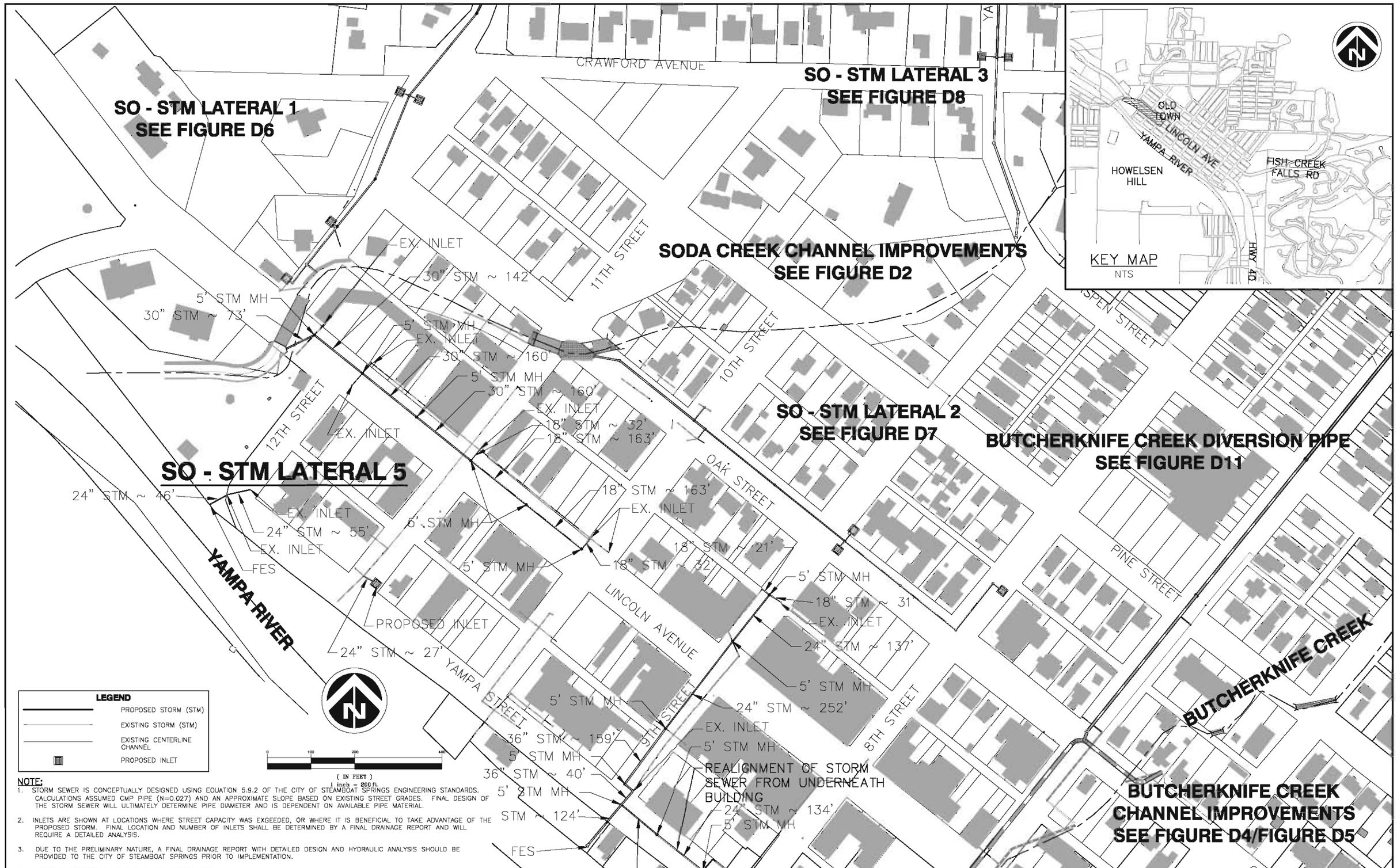
DESCRIPTION

Street capacity is exceeded at Design Point SO-F1, which is located at the intersection of Broad Street and Nob Street. Existing inlets are present at this location and an existing storm sewer lateral conveys flow past the school to Soda Creek. Pipe diameter and conditions of the existing infrastructure in the upper portions of the basin are unknown. Sizes of the existing storm sewer infrastructure adjacent to the recently redeveloped school were provided based on the design report. The recently installed storm sewer main that conveys flow to Soda Creek adjacent to the school is undersized for conveyance of the entire watershed. Therefore, SO - Storm Lateral 4 recommends upsizing the main conveyance line from Soda Creek to the intersection of Broad Street and Nob Street. Existing inlets and the infrastructure conveying flows will have to be evaluated at final design and may be adequate to convey runoff to the proposed main lateral.

Final design will need to determine final location of inlets and storm sewer and the number of inlets.

PRELIMINARY DESIGN COST ESTIMATE

Improvement	Quantity	Unit	Unit Cost	Total Cost
36" CMP	1,585	LF	$130.00	$206,050
30" CMP	335	LF	$110.00	$36,850
24" CMP	830	LF	$88.00	$73,040
18" CMP	65	EA	$60.00	$3,900
Inlets	1	EA	$5,000.00	$5,000
Manhole, 7' Diameter	2	EA	$5,000.00	$10,000
Manhole, 6' Diameter	6	EA	$3,400.00	$20,400
Manhole, 5' Diameter	6	EA	$2,500.00	$15,000
Riprap Outlet Protection	1	EA	$2,000.00	$2,000
Connection to Existing Infrastructure	11	EA	$3,000.00	$33,000
36" FES	1	EA	$1,115.00	$1,115
Total Estimated Construction Cost				$406,355
Utility Relocation (5% of Construction Cost)				$20,318
Engineering and Contingency (35% of Construction and Utility)				$149,335
TOTAL ESTIMATED COST				**$576,008**



NOTE:

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2. INLETS ARE SHOWN AT LOCATIONS WHERE STREET CAPACITY WAS EXGEEDED, OR WHERE IT IS BENEFICIAL TO TAKE ADVANTAGE OF THE PROPOSED STORM. FINAL LOCATION AND NUMBER OF INLETS SHALL BE DETERMINED BY A FINAL DRAINAGE REPORT AND WILL REQUIRE A DETAILED ANALYSIS.
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4. LENGTHS DEPIGTED ON THE PLAN ARE APPROXIMATE.

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CITY OF STEAMBOAT SPRINGS

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS

SODA CREEK STORM SEWER LATERAL 5

FIGURE D10

COMMENTARY FIGURE D10

SO - STM LATERAL 5

DESCRIPTION

SO - Storm Lateral 5 comprises of the storm sewer alignment along Lincoln Avenue. An existing storm line conveys flow but is inadequate for the design storm and required upsizing. The outfall of Storm Lateral 5 into Soda Creek is downstream of the bridge/culvert crossing under Lincoln Avenue.

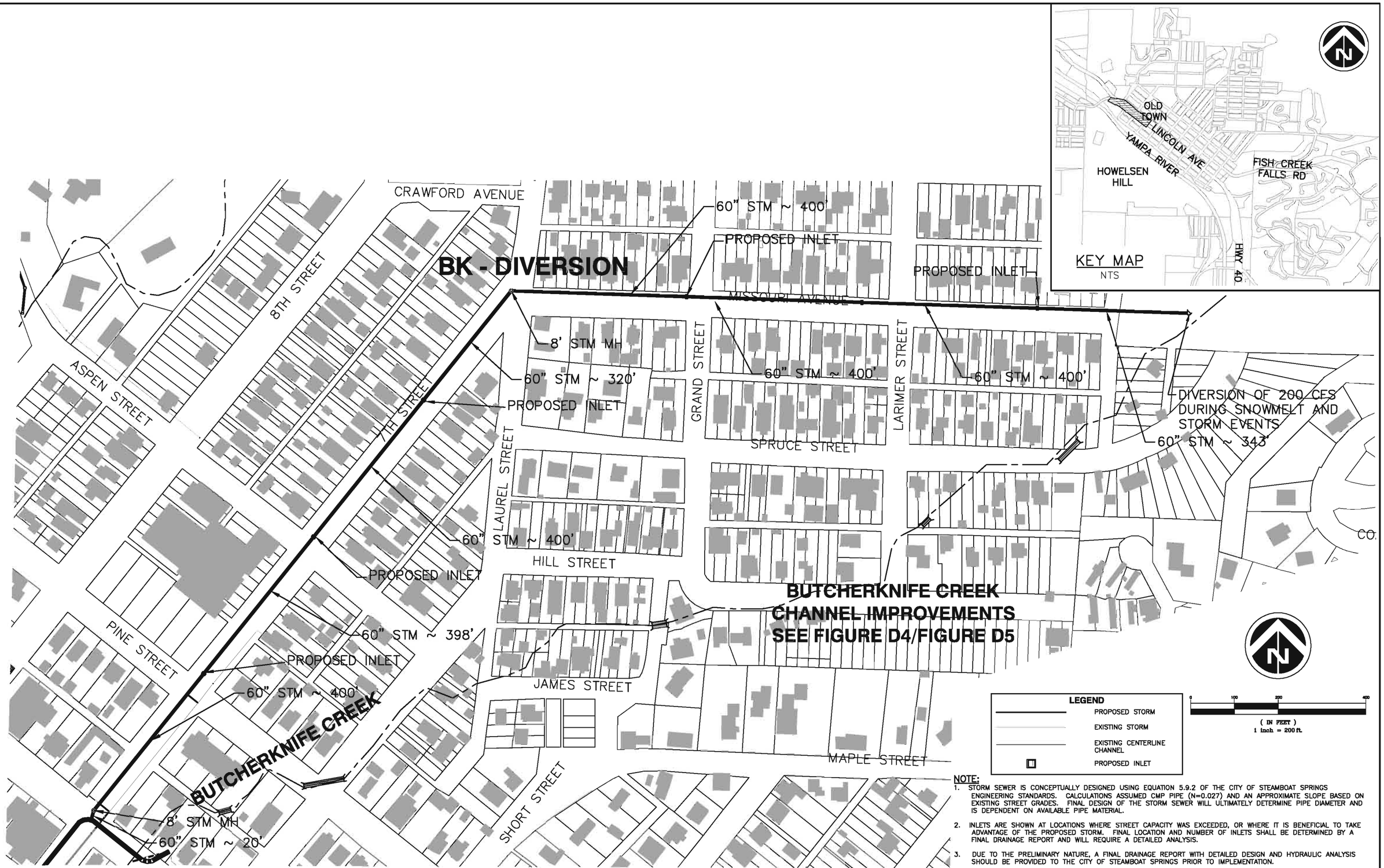
In addition to the main Storm Lateral 5, minor storm infrastructure improvements are also shown within Figure D10. These improvements comprise of increasing the storm sewer at the intersection of 12th Street and Yampa Street, adding an inlet for local nuisance drainage at the southeast corner of the intersection of 11th Street and Yampa Street, realigning the outfall under the Steamboat Yacht Club and combining and upsizing the storm outfall along 9th Street, and increasing size of the existing storm sewer along 9th Avenue between Lincoln Avenue and the alley to the northeast.

Final design will need to determine final location of inlets and storm sewer and the number of inlets.

PRELIMINARY DESIGN COST ESTIMATE

Improvement	Quantity	Unit	Unit Cost	Total Cost
30" CMP	880	LF	$110.00	$96,800
24" CMP	780	LF	$88.00	$68,640
18" CMP	430	EA	$60.00	$25,800
Manhole, 5' Diameter	13	EA	$2,500.00	$32,500
Riprap Outfall Protection	4	EA	$2,000.00	$8,000
Connection to Existing Infrastructure	15	EA	$3,000.00	$45,000
Head Wall, Pipe Penetration	1	EA	$5,000.00	$5,000
24" FES	1	EA	$975.00	$975
30" FES	1	EA	$1,050.00	$1,050

Total Estimated Construction Cost	$283,765
Utility Relocation (5% of Construction Cost)	$14,188
Engineering and Contingency (35% of Construction and Utility)	$104,284
TOTAL ESTIMATED COST	**$402,237**



NOTE:

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4. LENGTHS DEPICTED ON THE PLAN ARE APPROXIMATE.

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CITY OF STEAMBOAT SPRINGS

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS

BUTCHERKNIFE CREEK DIVERSION PIPE

FIGURE D11

COMMENTARY FIGURE D11

BUTCHERKNIFE CREEK DIVERSION

DESCRIPTION

To reduce the 100-year flows in Butcherknife Creek, an in-channel diversion structure and diversion pipe are proposed. The Butcherknife Creek Diversion Pipe is modeled and priced as a 60" RCP. The improvements will reduce the peak storm event and snowmelt runoff within the main channel of Butcherknife Creek. The main channel of Butcherknife Creek has limited flow capacity so the overflow pipe helps to minimize nuisance flooding along the channel corridor and flooding caused by storm events. The 60" diversion pipe was conceptually designed to convey approximately 200 cfs and is aligned along Missouri Avenue to 7th Street. Near the intersection of 7th Street and Oak Street, the diversion would connect to the 4-foot high by 8-foot wide reinforced concrete box culvert discussed in commentary Figure D4 for the recombined full flow along Butcherknife Creek.

The City specifies CMP, but due to the large diameter of this diversion pipe, it may be necessary to select a pipe material with improved hydraulic performance. A price competitive alternative may include steel reinforced HDPE, which combines many of the distinct benefits found individually with RCP and CMP.

The price of the diversion structure may vary greatly depending on the how sophisticated the City wishes the structure to be. It is possible to incorporate telemetry, SCADA, and/or automatic controls that regulate the peak flow within Butcherknife Creek. For this reason, a middle of the road unit cost was selected.

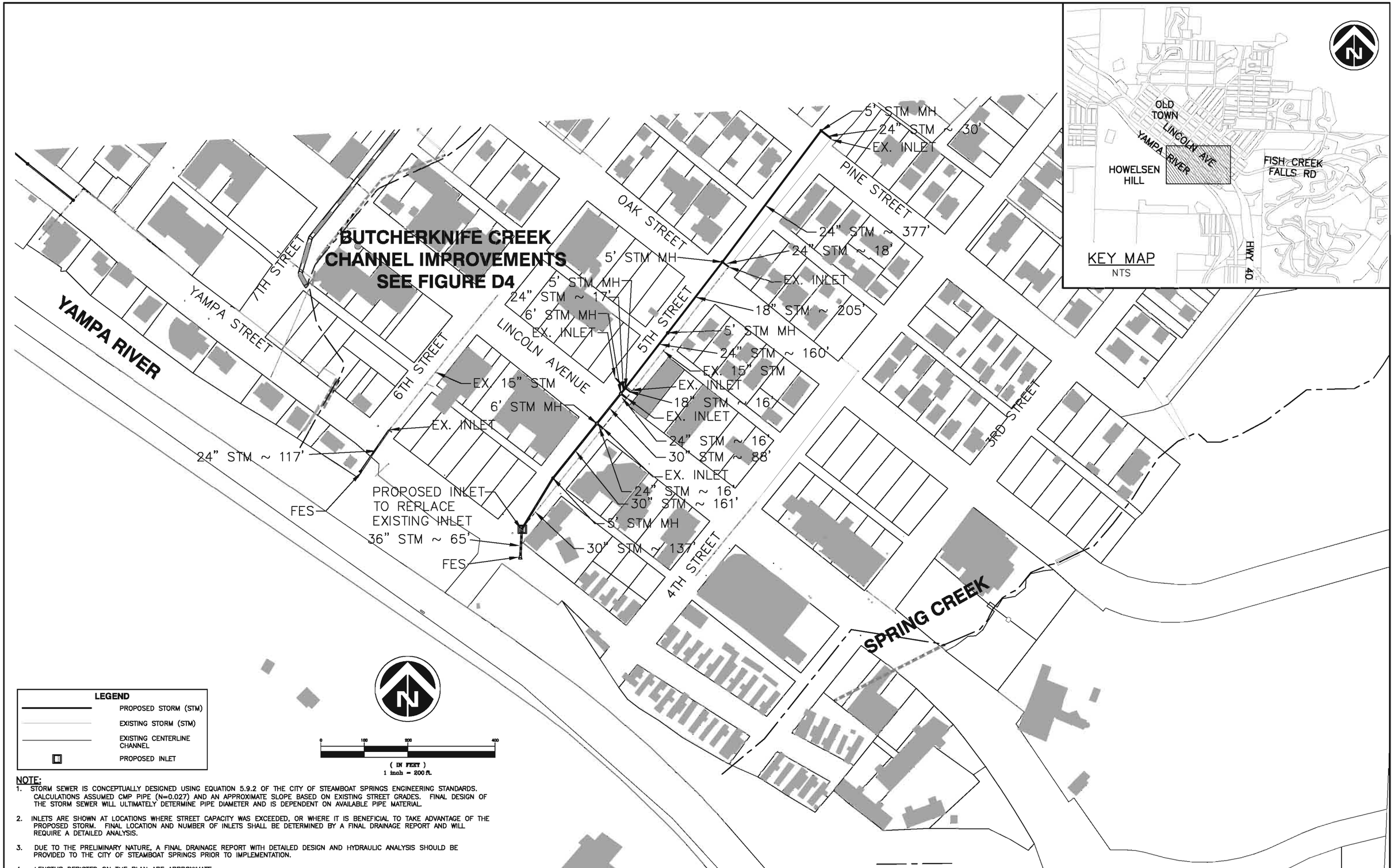
The diversion pipe also provides conveyance for some local drainage along 7th Avenue.

Final design will need to determine final location of inlets and storm sewer and the number of inlets.

PRELIMINARY DESIGN COST ESTIMATE

Improvement	Quantity	Unit	Unit Cost	Total Cost
60" RCP	3,085	LF	$220.00	$678,700
18" CMP	55	LF	$60.00	$3,300
Manhole, Box Base	8	EA	$10,000.00	$80,000
Connect to Existing Infrastructure	2	EA	$3,000.00	$6,000
Diversion Structure	1	EA	$50,000.00	$50,000

Total Estimated Construction Cost	$818,000
Utility Relocation (5% of Construction Cost)	$40,900
Engineering and Contingency (35% of Construction and Utility)	$300,615
TOTAL ESTIMATED COST	**$1,159,515**



NOTE:

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4. LENGTHS DEPICTED ON THE PLAN ARE APPROXIMATE.

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CITY OF STEAMBOAT SPRINGS

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS

DFA–YAMPA STORM IMPROVEMENTS

FIGURE D12

COMMENTARY FIGURE D12

DFA - Yampa Storm Improvements

DESCRIPTION

DFA Yampa Storm Improvements include the lateral improvements along 5th Street and 6th Street. The lateral line along 5th Street needs to improved to provide additional drainage conveyance capacity between the outfall at the Yampa River to Lincoln Avenue. Along 6th Avenue the storm sewer from the outfall at the Yampa River to the inlet on the upstream side (northeast) of Yampa Street.

Final design will need to determine final location of inlets and storm sewer and the number of inlets.

PRELIMINARY DESIGN COST ESTIMATE

Improvement	Quantity	Unit	Unit Cost	Total Cost
36" CMP	65	LF	$130.00	$8,450
30" CMP	390	LF	$110.00	$42,900
24" CMP	935	LF	$88.00	$82,280
18" CMP	65	LF	$60.00	$3,900
Manhole, 6' Diameter	2	EA	$3,400.00	$6,800
Manhole, 5' Diameter	5	EA	$2,500.00	$12,500
Riprap Outfall Protection	2	EA	$2,000.00	$4,000
Connection to Existing Infrastructure	6	EA	$3,000.00	$18,000
24" FES	1	EA	$975.00	$975
36" FES	1	EA	$1,115.00	$1,115

Total Estimated Construction Cost	$180,920
Utility Relocation (5% of Construction Cost)	$9,046
Engineering and Contingency (35% of Construction and Utility)	$66,488
TOTAL ESTIMATED COST	**$256,454**

STORM SEWER DESIGN

Soda Creek

Job No.	50500101
Date	4/16/2009
Calculated By	JRD
Checked By	KSC

DESIGN EQUATION:

Intial storm sewer size and design is based on Equation 5.9.2 of the Steamboat Springs Engineering Standards. It states:

$$D_i = \left[\frac{2.16 n Q_p}{S_o^{1/2}} \right]^{3/8}$$

Where: n = Manning's Roughness Coefficient
Q = Peak Discharge (cfs)
S = Slope (ft/ft)

ASSUMPTIONS:

1. Corrugated Metal Pipe will be utilized for storm conveyance (n = 0.027)
2. Slope of the storm sewer is approximated by the controlling roadway slope (i.e. the mildest slope)
3. Storm sewer designed for minor storm event (5-year)
4. Due to the conceptual nature of the study, a factor of safety was added

DESIGN:

Mannings n	0.027
Factor of Safety	10%

Design Point	Design Discharge (cfs)	Estimated Slope of Pipe (ft/ft)	Initial Pipe Diameter (ft)	Applying Factor of Safety	Selected Pipe Diameter (ft)
B3	24.62	0.020	2.38	2.62	3.00
B4	26.4	0.050	2.06	2.27	2.50
B5	29.46	0.020	2.55	2.81	3.00
B6	35.62	0.020	2.74	3.01	3.50
B8	38.93	0.030	2.62	2.89	3.00
B10	41.47	0.015	3.06	3.37	3.50
C3	28.33	0.03	2.33	2.56	3.00
C5	33.97	0.06	2.19	2.41	2.50
C7	34.44	0.02	2.70	2.98	3.00
F1	11.02	0.06	1.44	1.58	2.00
F2	5.67	0.01	1.57	1.72	2.00
F3	12.33	0.01	2.10	2.31	2.50
F4	3.76	0.05	0.99	1.09	1.25
F5	26.70	0.015	2.59	2.85	3.00
F7	29.50	0.015	2.69	2.96	3.00
G3	6.81	0.01	1.68	1.85	2.00
G4	18.84	0.01	2.46	2.70	3.00
H1	5.19	0.02	1.33	1.46	1.50
H2	10.19	0.01	1.95	2.15	2.50
H3	15.14	0.01	2.26	2.49	2.50

COMMENTS:

1. Due to the conceptual nature of the pipe calculations, a final design report should required and include detail information such as hydraulic design, plan and profiles, etc.

STORM SEWER DESIGN

Direct Flow Area - Yampa River

Job No.	50500101
Date	4/16/2009
Calculated By	JRD
Checked By	KSC

DESIGN EQUATION:

Intial storm sewer size and design is based on Equation 5.9.2 of the Steamboat Springs Engineering Standards. It states:

$$D_i = \left[\frac{2.16 n Q_p}{S_o^{1/2}} \right]^{3/8}$$

Where: n = Manning's Roughness Coefficient
Q = Peak Discharge (cfs)
S = Slope (ft/ft)

ASSUMPTIONS:

1. Corrugated Metal Pipe will be utilized for storm conveyance (n = 0.027)
2. Slope of the storm sewer is approximated by the controlling roadway slope (i.e. the mildest slope)
3. Storm sewer designed for minor storm event (5-year)
4. Due to the conceptual nature of the study, a factor of safety was added

DESIGN:

Mannings n	0.027
Factor of Safety	10%

Design Point	Design Discharge (cfs)	Estimated Slope of Pipe (ft/ft)	Initial Pipe Diameter (ft)	Applying Factor of Safety	Selected Pipe Diameter (ft)
Y1	6.00	0.010	1.60	1.76	2.00
Y2	0.64	0.010	0.69	0.76	1.25
Y3	1.40	0.020	0.81	0.90	1.25
Y4	6.11	0.020	1.41	1.56	2.00
Y5	7.72	0.030	1.43	1.57	2.00
Y6	4.06	0.010	1.38	1.52	2.00
Y7	3.87	0.010	1.36	1.49	1.50
Y8	4.06	0.010	1.38	1.52	2.00
Y9	7.15	0.010	1.71	1.88	2.00
Y10	12.09	0.010	2.08	2.29	2.50
Y11	5.60	0.010	1.56	1.71	2.00
Y12	6.23	0.010	1.62	1.78	2.00
Y13	6.16	0.020	1.42	1.56	2.00
Y14	9.40	0.020	1.66	1.83	2.00
Y15	13.02	0.010	2.14	2.35	2.50
Y20	4.87	0.020	1.30	1.43	1.50
Y21	3.00	0.020	1.08	1.19	1.25
Y22	11.67	0.010	2.05	2.26	2.50

STORM SEWER DESIGN

Direct Flow Area - Yampa River

Job No.	50500101
Date	4/16/2009
Calculated By	JRD
Checked By	KSC

DESIGN EQUATION:

Intial storm sewer size and design is based on Equation 5.9.2 of the Steamboat Springs Engineering Standards. It states:

$$D_i = \left[\frac{2.16 n Q_p}{S_o^{1/2}} \right]^{3/8}$$

Where: n = Manning's Roughness Coefficient
Q = Peak Discharge (cfs)
S = Slope (ft/ft)

ASSUMPTIONS:

1. Corrugated Metal Pipe will be utilized for storm conveyance (n = 0.027)
2. Slope of the storm sewer is approximated by the controlling roadway slope (i.e. the mildest slope)
3. Storm sewer designed for minor storm event (5-year)
4. Due to the conceptual nature of the study, a factor of safety was added

DESIGN:

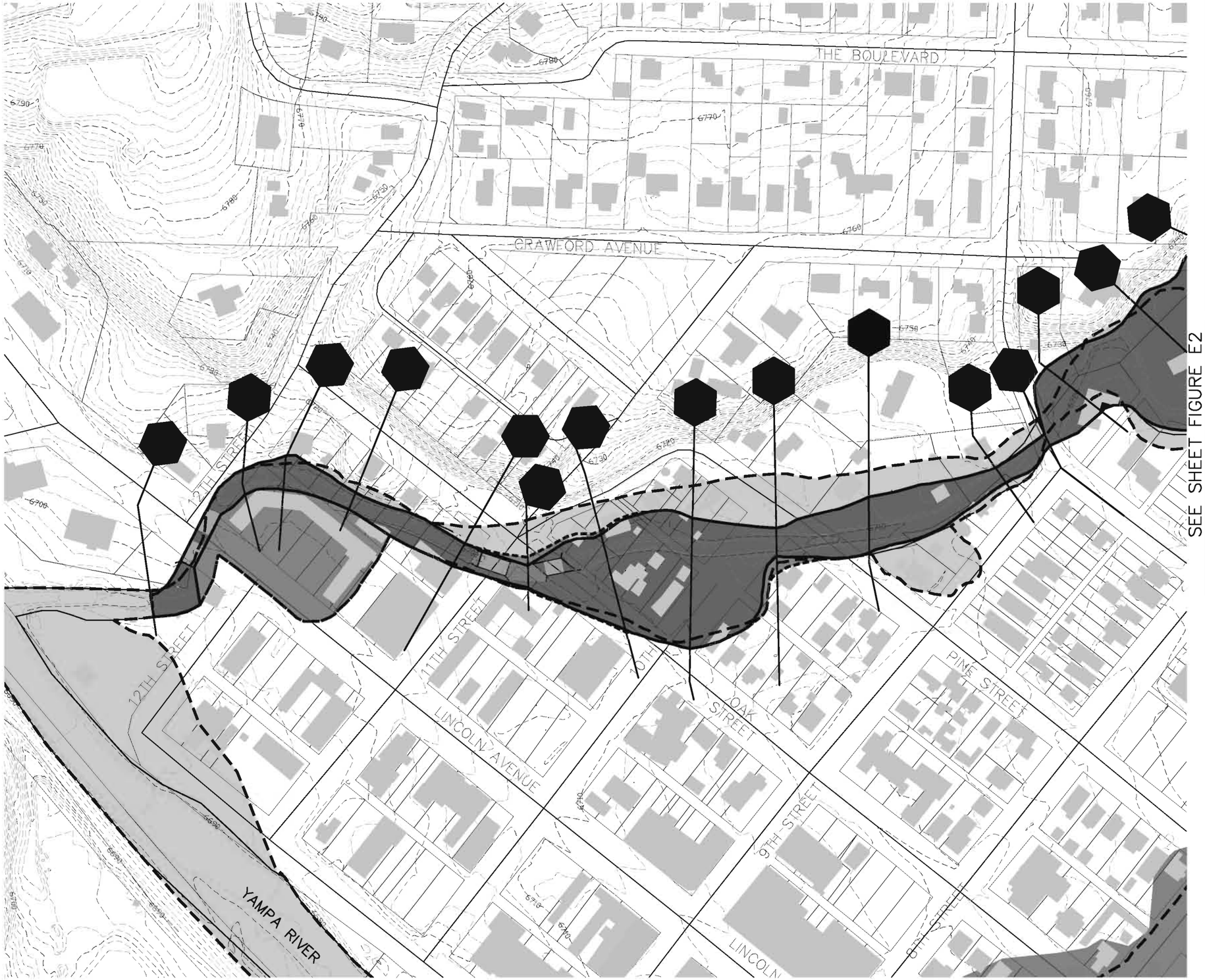
Mannings n	0.027
Factor of Safety	10%

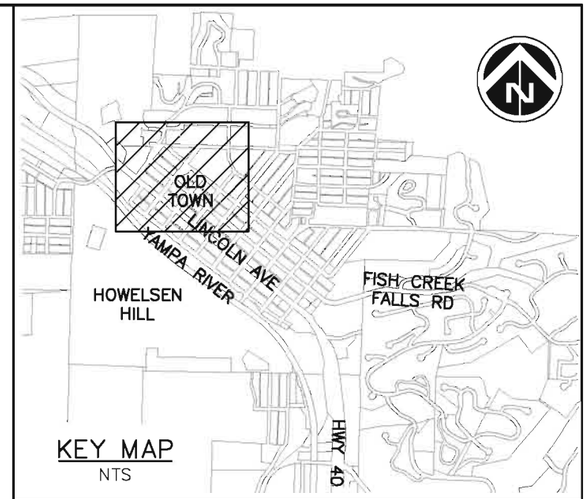
Design Point	Design Discharge (cfs)	Estimated Slope of Pipe (ft/ft)	Initial Pipe Diameter (ft)	Applying Factor of Safety	Selected Pipe Diameter (ft)
Y23a	8.20	0.030	1.46	1.61	2.00
Y23	10.30	0.020	1.72	1.89	2.00
Y24	1.66	0.020	0.87	0.95	1.25
Y25	0.76	0.010	0.74	0.81	1.25
Y26	17.30	0.020	2.09	2.30	2.50
Y27	22.10	0.010	2.61	2.87	3.00
Y28	5.15	0.010	1.51	1.66	2.00
Y29	8.77	0.020	1.62	1.78	2.00
Y30	11.52	0.020	1.79	1.97	2.00

COMMENTS:

1. Due to the conceptual nature of the pipe calculations, a final design report should required and include detail information such as hydraulic design, plan and profiles, etc.

APPENDIX E:
HEC-RAS OUTPUT





KEY MAP
NTS

LEGEND

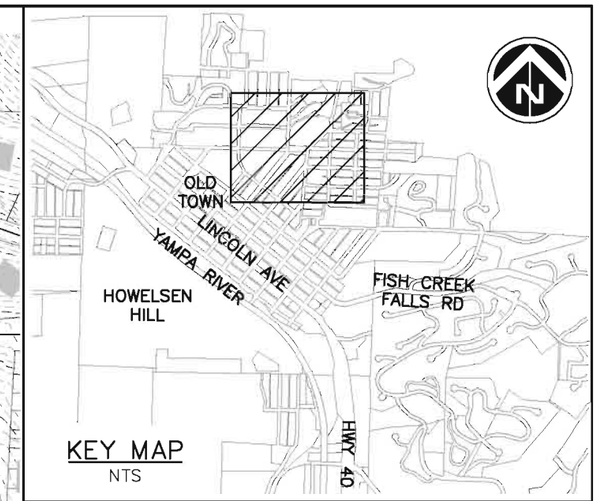
- PROPOSED 100–YR FLOODPLAIN
- CORRECTED EFFECTIVE 100–YR FLOODPLAIN
- FEMA DUPLICATE EFFECTIVE 100–YR FLOODPLAIN
- 5350 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- XS–1 APPROXIMATE LOCATION OF LOMR SECTION

NOTE:
1. DOWNSTREAM BOUNDARY CONDITION FOR CORRECTED EFFECTIVE FLOODPLAIN IS XS–1.

0 100 200 400

(IN FEET)
1 inch = 200ft.

J3 Engineering Consultants Inc. 3151 S. Vaughn Way, Suite 680 Aurora, CO 80014 Tel: 303-368-5601 Fax: 303-368-5603	DESIGNED BY: JRD DATE: 11/14/08 DRAWN BY: JAN DATE: 02/28/09 CHECKED BY: KSC DATE: 04/17/09	CITY OF STEAMBOAT SPRINGS	OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS	SODA CREEK WORK MAP	FIGURE E1



LEGEND

- PROPOSED 100–YR FLOODPLAIN
- CORRECTED EFFECTIVE 100–YR FLOODPLAIN
- FEMA DUPLICATE EFFECTIVE 100–YR FLOODPLAIN
- 5350 — EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- XS–1 — APPROXIMATE LOCATION OF LOMR SECTION

NOTE:
1. DOWNSTREAM BOUNDARY CONDITION FOR CORRECTED EFFECTIVE FLOODPLAIN IS XS–1.

0 100 200 400

(IN FEET)
1 inch = 200ft.

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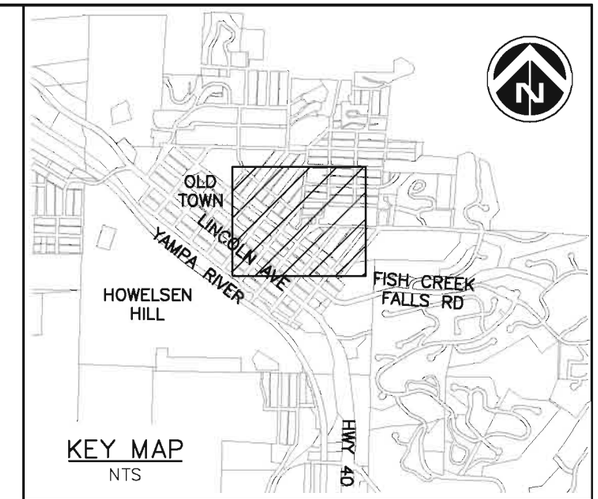
CHECKED BY: KSC	DATE: 04/17/09	

CITY OF STEAMBOAT SPRINGS

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS

SODA CREEK WORK MAP

FIGURE E2



KEY MAP
NTS

LEGEND

- PROPOSED 100-YR FLOODPLAIN (200 CFS DIVERSION WITH NO CULVERT IMPROVEMENTS)
- CORRECTED EFFECTIVE 100-YR FLOODPLAIN
- FEMA DUPLICATE EFFECTIVE 100-YR FLOODPLAIN
- 5350 — EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- XS-1 — APPROXIMATE LOCATION OF LOMR SECTION

NOTE:
1. DOWNSTREAM BOUNDARY CONDITION FOR CORRECTED EFFECTIVE FLOODPLAIN IS XS-2.
2. THIS SCENARIO ASSUMES A DIVERSION PIPE REDUCES THE FLOW WITHIN THE MAIN CHANNEL BY 200 CFS AND NO CULVERT IMPROVEMENTS.

0 100 200 400

(IN FEET)
1 inch = 200ft.

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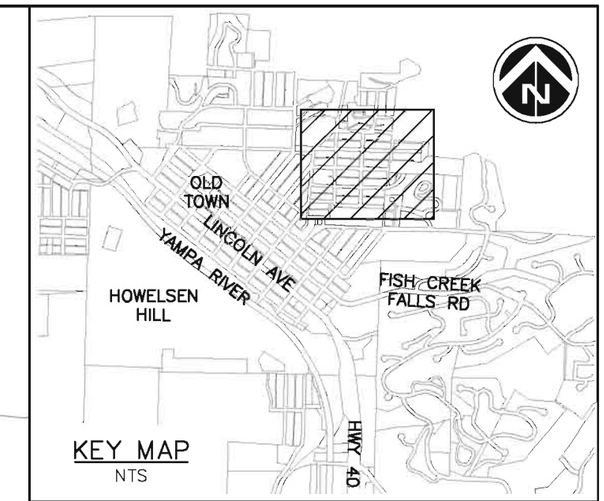
CHECKED BY: KSC	DATE: 04/17/09	

CITY OF STEAMBOAT SPRINGS

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS

BUTCHERKNIFE CREEK 200 CFS DIVERSION WITH NO CULVERT IMPROVEMENTS WORK MAP

FIGURE E3



KEY MAP
NTS

LEGEND

- PROPOSED 100-YR FLOODPLAIN (200 CFS DIVERSION WITH NO CULVERT IMPROVEMENTS)
- CORRECTED EFFECTIVE 100-YR FLOODPLAIN
- FEMA DUPLICATE EFFECTIVE 100-YR FLOODPLAIN
- 5350 — EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- XS-1 — APPROXIMATE LOCATION OF LOMR SECTION

NOTE:

1. DOWNSTREAM BOUNDARY CONDITION FOR CORRECTED EFFECTIVE FLOODPLAIN IS XS-2.
2. THIS SCENARIO ASSUMES A DIVERSION PIPE REDUCES THE FLOW WITHIN THE MAIN CHANNEL BY 200 CFS AND NO CULVERT IMPROVEMENTS.

0 100 200 400

(IN FEET)
1 inch = 200ft.

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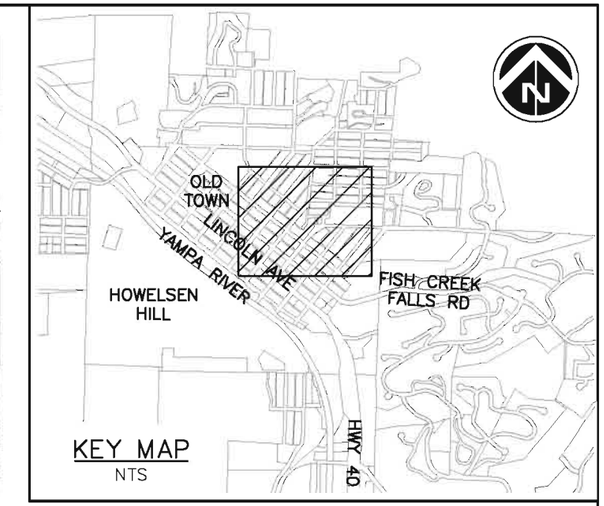

LEGEND

- PROPOSED 100–YR FLOODPLAIN (200 CFS DIVERSION WITH CULVERT IMPROVEMENTS)
- CORRECTED EFFECTIVE 100–YR FLOODPLAIN
- FEMA DUPLICATE EFFECTIVE 100–YR FLOODPLAIN
- 5350 — EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- XS–1 — APPROXIMATE LOCATION OF LOMR SECTION
- LOCATION OF CULVERT IMPROVEMENTS

NOTE:
1. DOWNSTREAM BOUNDARY CONDITION FOR CORRECTED EFFECTIVE FLOODPLAIN IS XS–2.
2. THIS SCENARIO ASSUMES A DIVERSION PIPE REDUCES THE FLOW WITHIN THE MAIN CHANNEL BY 200 CFS AND PROPOSED CULVERT IMPROVEMENTS WERE IMPLEMENTED.

0 100 200 400

(IN FEET)
1 inch = 200ft.

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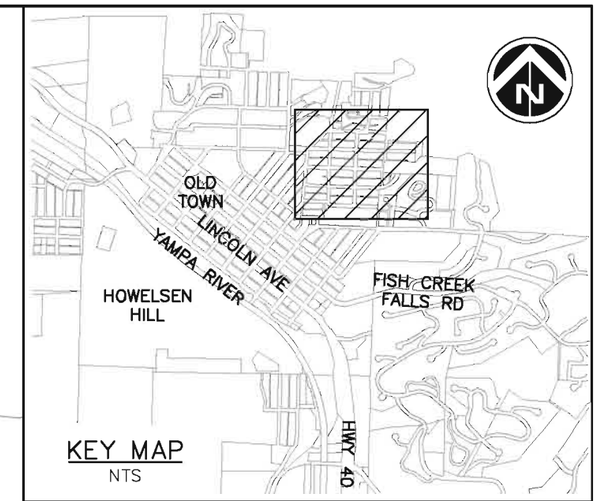
CITY OF STEAMBOAT SPRINGS

OLD TOWN DRAINAGE STUDY AND FLOODPLAIN MASTER PLAN FOR SPRING, BUTCHERKNIFE AND SODA CREEKS

BUTCHERKNIFE CREEK 200 CFS DIVERSION WITH CULVERT IMPROVEMENTS WORK MAP

FIGURE E5



KEY MAP
NTS

LEGEND

- PROPOSED 100–YR FLOODPLAIN (200 CFS DIVERSION WITH CULVERT IMPROVEMENTS)
- CORRECTED EFFECTIVE 100–YR FLOODPLAIN
- FEMA DUPLICATE EFFECTIVE 100–YR FLOODPLAIN
- 5350 — EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- XS–1 — APPROXIMATE LOCATION OF LOMR SECTION
- LOCATION OF CULVERT IMPROVEMENTS

NOTE:

1. DOWNSTREAM BOUNDARY CONDITION FOR CORRECTED EFFECTIVE FLOODPLAIN IS XS–2.
2. THIS SCENARIO ASSUMES A DIVERSION PIPE REDUCES THE FLOW WITHIN THE MAIN CHANNEL BY 200 CFS AND PROPOSED CULVERT IMPROVEMENTS WERE IMPLEMENTED.

0 100 200 400

(IN FEET)
1 inch = 200ft.

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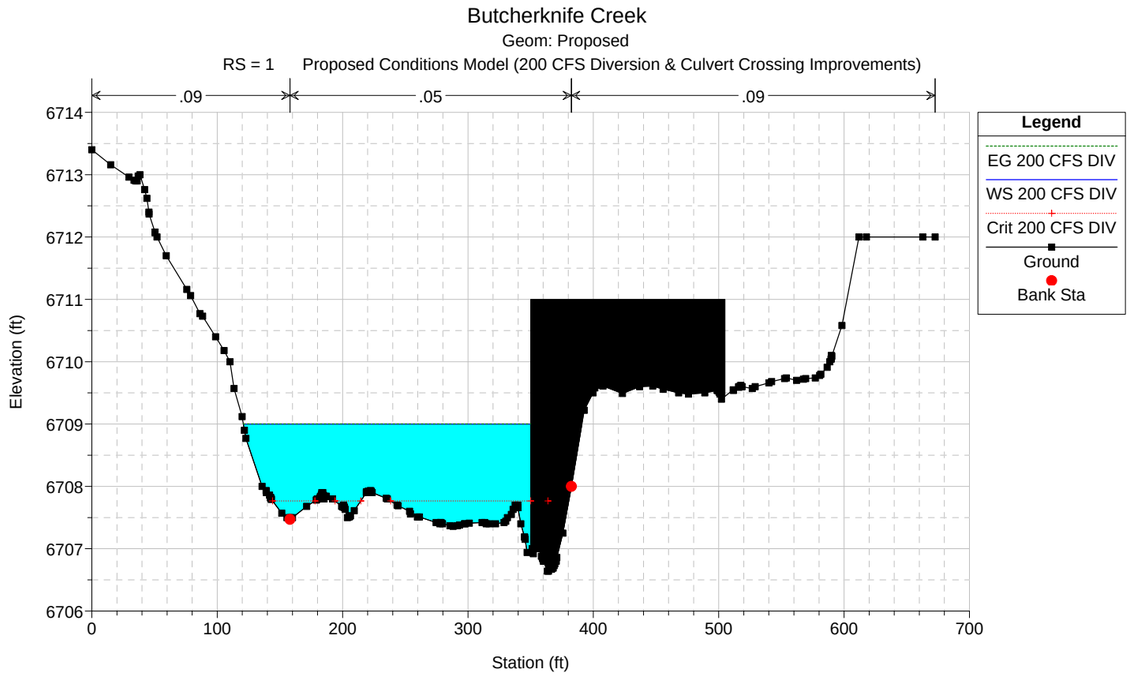
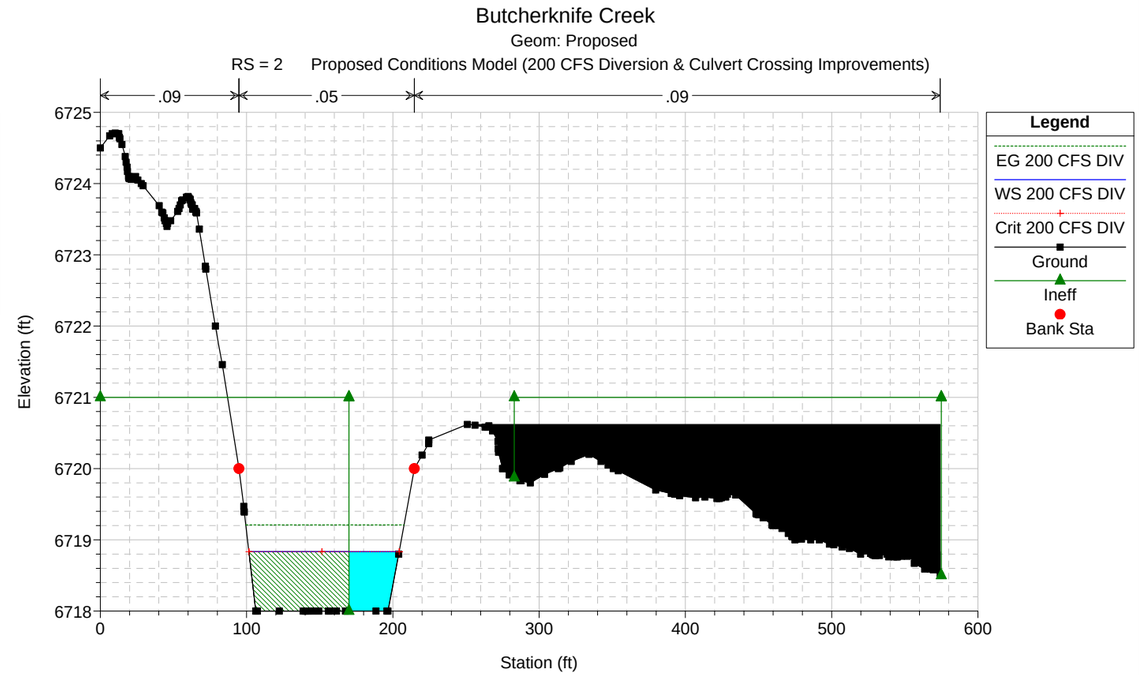
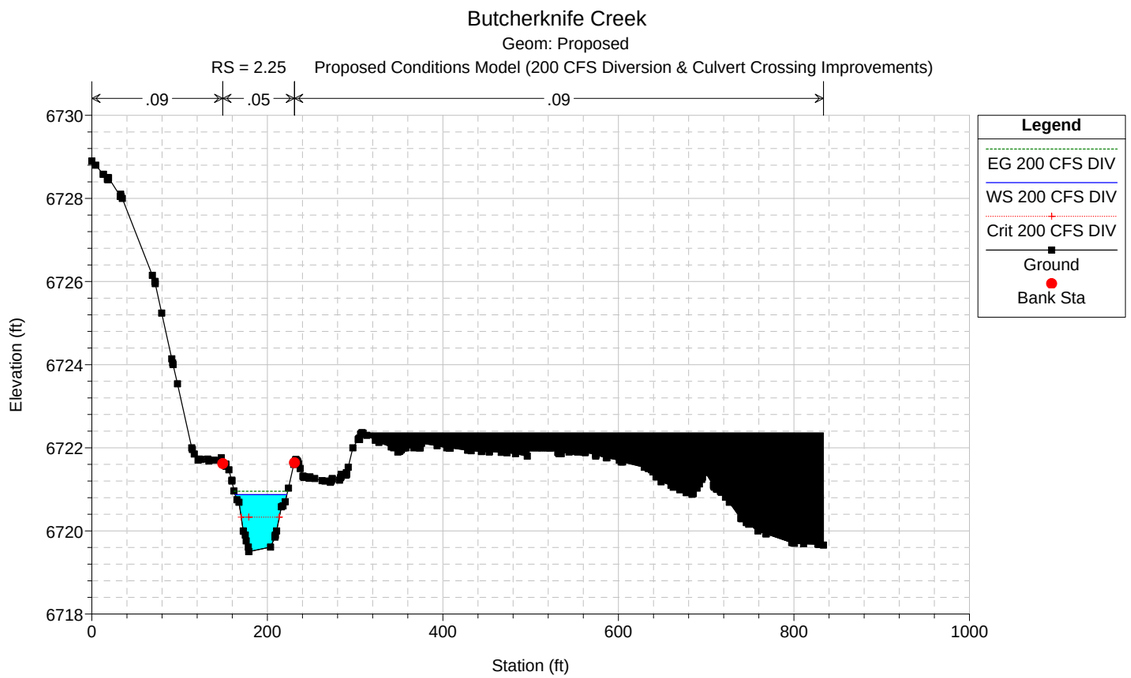
HEC-RAS OUTPUT FOR BUTCHERKNIFE CREEK – PROPOSED CONDITIONS MODEL

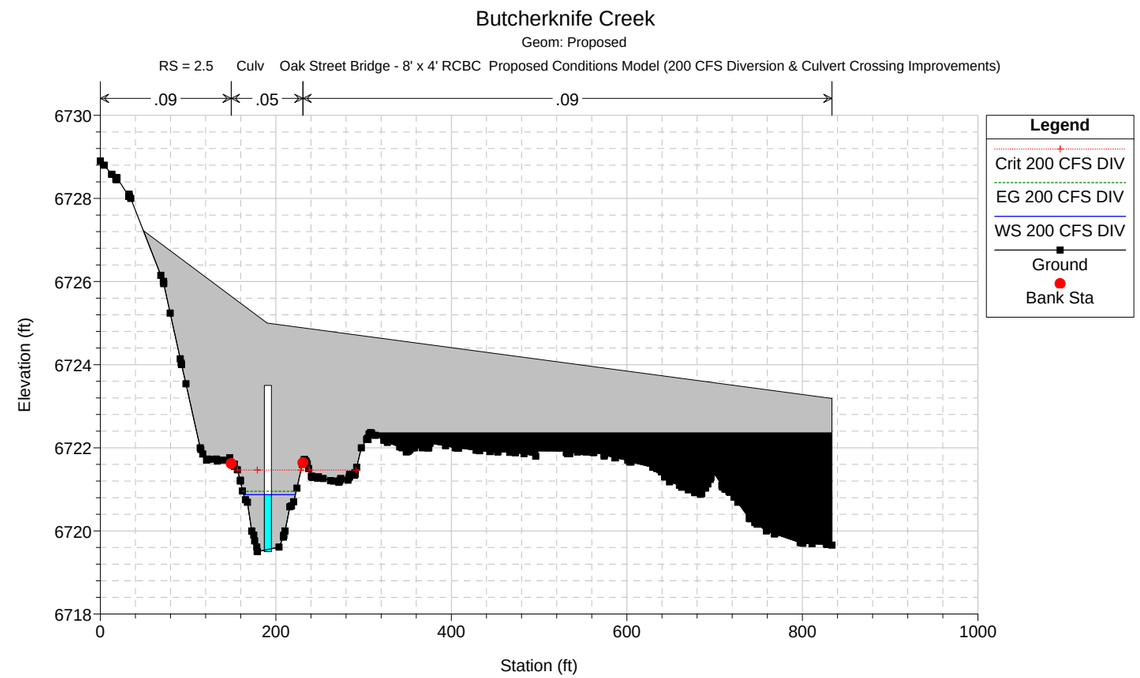
Butcherknife Creek - Proposed Conditions Model (200 CFS Diverion & Culvert Improvements)

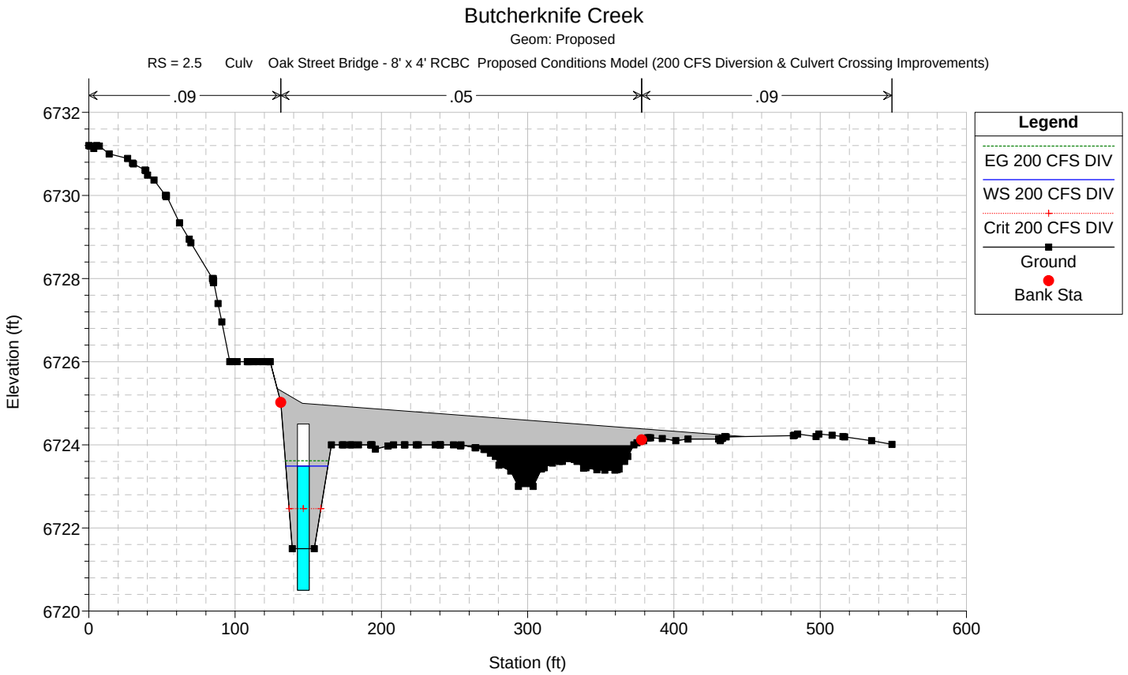
Reach	River Sta	Flood Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach-1	13	200 CFS DIV	125	6769.8	6770.37		6770.43	0.01439	1.95	65.5	213.4	0.54
Reach-1	12.5	200 CFS DIV	125	6761.55	6764.49	6764.09	6764.84	0.01937	4.75	26.3	20.4	0.74
Reach-1	12.25		Culvert									
Reach-1	12.1	200 CFS DIV	125	6761.35	6763.15		6763.34	0.01546	3.49	35.8	38.8	0.64
Reach-1	12	200 CFS DIV	125	6760.32	6761.94	6761.94	6762.39	0.03890	5.39	23.2	26.1	1.01
Reach-1	11.5	200 CFS DIV	125	6755.25	6759.15	6757.55	6759.21	0.00206	1.97	63.5	181.3	0.26
Reach-1	11.25		Culvert									
Reach-1	11	200 CFS DIV	125	6755	6758.31	6757.57	6758.55	0.01033	3.92	31.9	178.6	0.55
Reach-1	10	200 CFS DIV	125	6752	6753.02	6753.02	6753.39	0.04136	4.90	25.5	54.0	1.01
Reach-1	9.5	200 CFS DIV	125	6746	6749.68	6746.85	6749.69	0.00003	0.33	474.0	241.0	0.03
Reach-1	9.25		Culvert									
Reach-1	9	200 CFS DIV	125	6745.83	6747.01	6747.01	6747.37	0.04245	4.83	25.9	115.2	1.02
Reach-1	8	200 CFS DIV	125	6742	6743.24		6743.34	0.01528	2.52	49.6	86.8	0.59
Reach-1	7	200 CFS DIV	125	6738	6738.89		6738.99	0.01471	2.64	49.0	173.5	0.59
Reach-1	6	200 CFS DIV	125	6732.19	6734.43	6734.39	6734.77	0.03371	4.69	27.1	40.2	0.92
Reach-1	5.5	200 CFS DIV	125	6730	6733.58	6731.63	6733.62	0.00168	1.62	77.2	462.9	0.23
Reach-1	5	200 CFS DIV	125	6730	6733.32	6731.98	6733.55	0.00613	3.80	32.9	465.4	0.42
Reach-1	4.5		Culvert									
Reach-1	4.25	200 CFS DIV	125	6728	6728.97	6728.97	6729.35	0.04058	4.93	25.4	33.9	1
Reach-1	4	200 CFS DIV	125	6726	6727.69		6727.77	0.00497	2.34	53.5	45.3	0.38
Reach-1	3	200 CFS DIV	125	6724.46	6725.81	6725.81	6726.24	0.03832	5.31	23.5	61.4	1
Reach-1	2.75	200 CFS DIV	125	6721.5	6723.49	6722.67	6723.62	0.00554	2.87	43.5	28.8	0.41
Reach-1	2.5		Culvert									
Reach-1	2.25	200 CFS DIV	125	6719.5	6720.87	6720.33	6720.95	0.00669	2.30	54.3	58.9	0.42
Reach-1	2	200 CFS DIV	125	6718	6718.83	6718.83	6719.21	0.04090	4.92	25.4	102.7	1.01
Reach-1	1	200 CFS DIV	125	6706.94	6709	6707.77	6709.00	0.00013	0.43	311.1	229.2	0.06

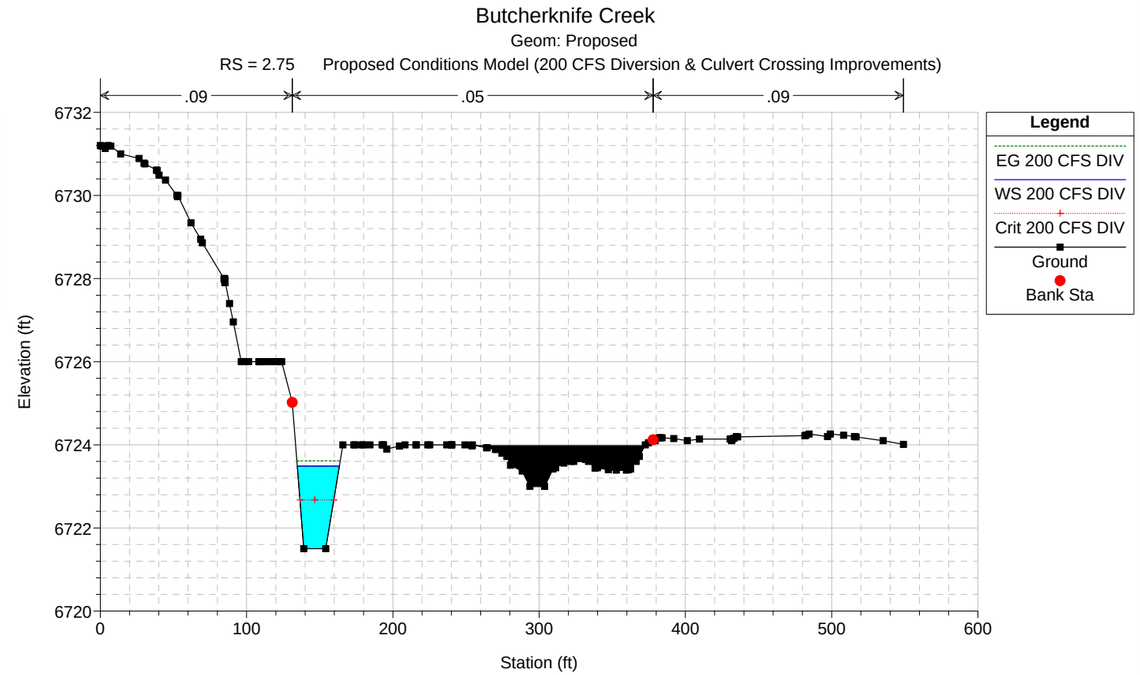

Butcherknife Creek
Geom: Proposed
RS = 1 Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Bank Sta
Elevation (ft)
Station (ft)

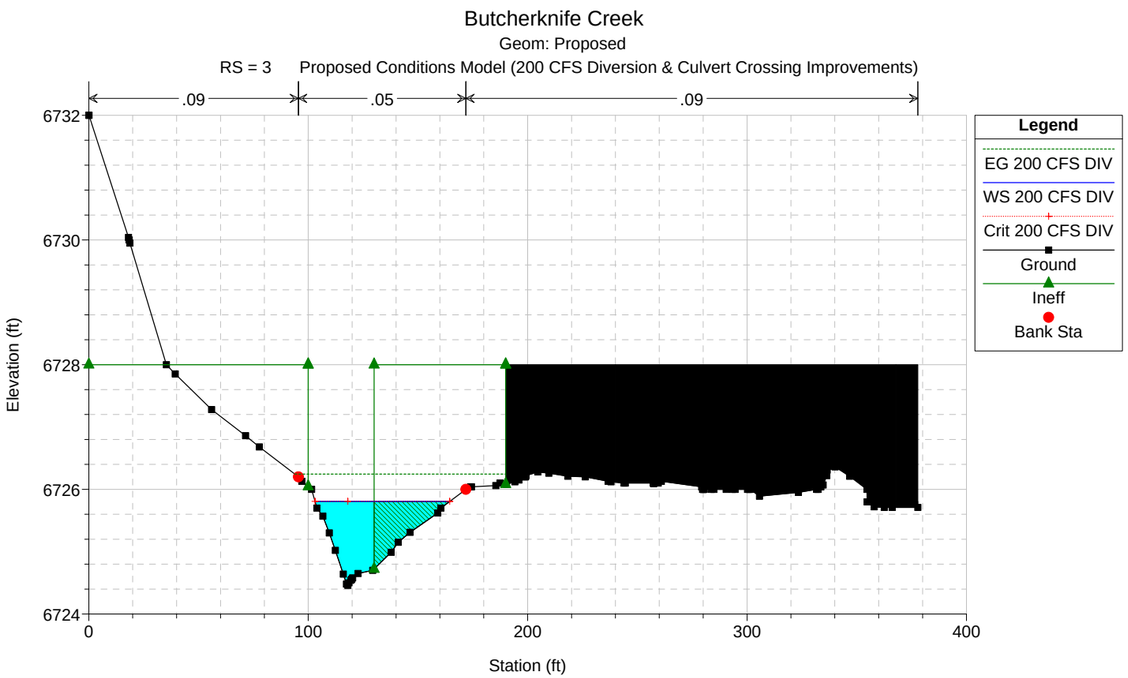

Butcherknife Creek
Geom: Proposed
RS = 2 Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

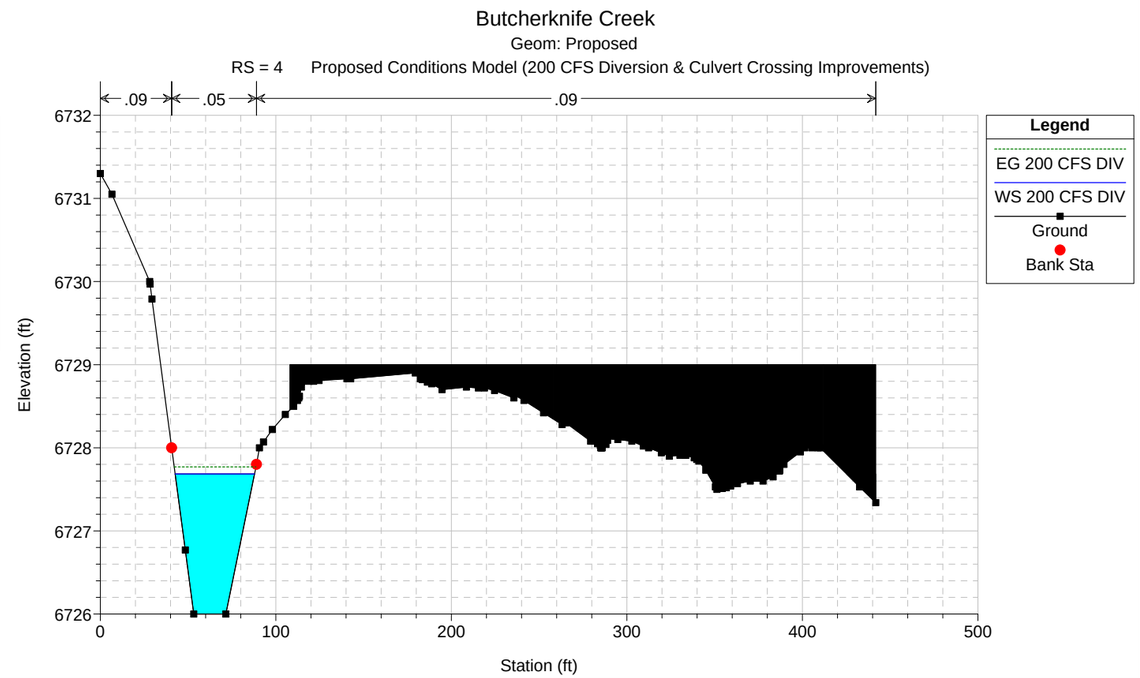

Butcherknife Creek
Geom: Proposed
RS = 2.25 Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Bank Sta
Elevation (ft)
Station (ft)

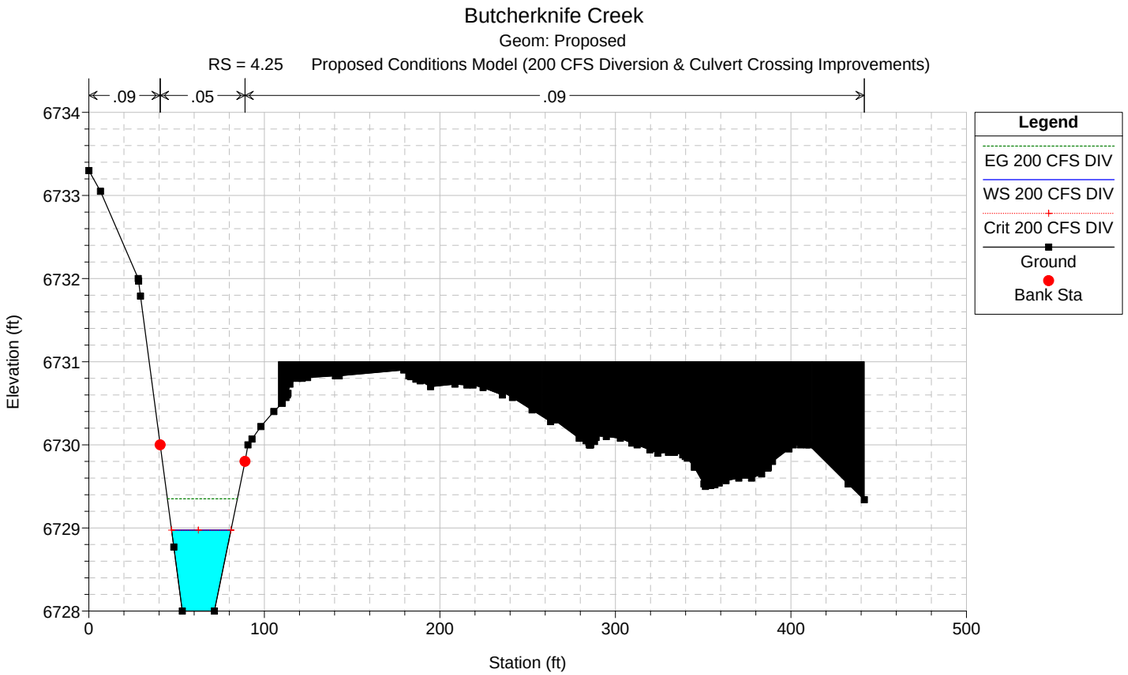

Butcherknife Creek
Geom: Proposed
RS = 2.5 Culv Oak Street Bridge - 8' x 4' RCBC Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
Crit 200 CFS DIV
EG 200 CFS DIV
WS 200 CFS DIV
Ground
Bank Sta
Elevation (ft)
Station (ft)

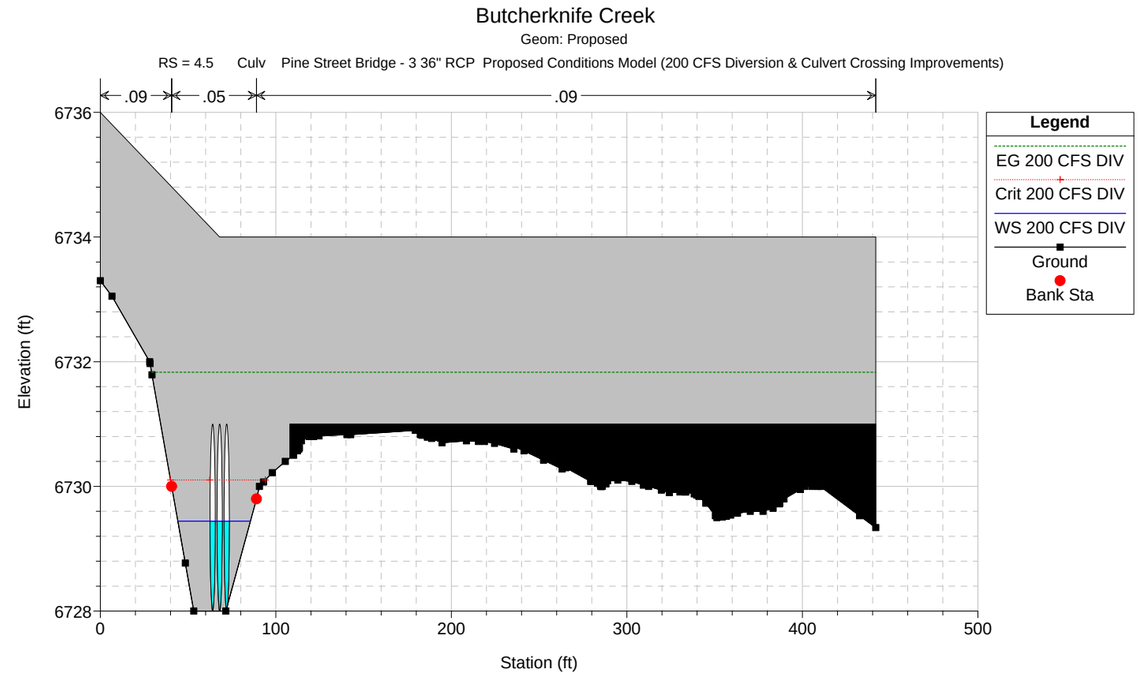

Butcherknife Creek
Geom: Proposed
RS = 2.5 Culv Oak Street Bridge - 8' x 4' RCBC Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Bank Sta
Elevation (ft)
Station (ft)

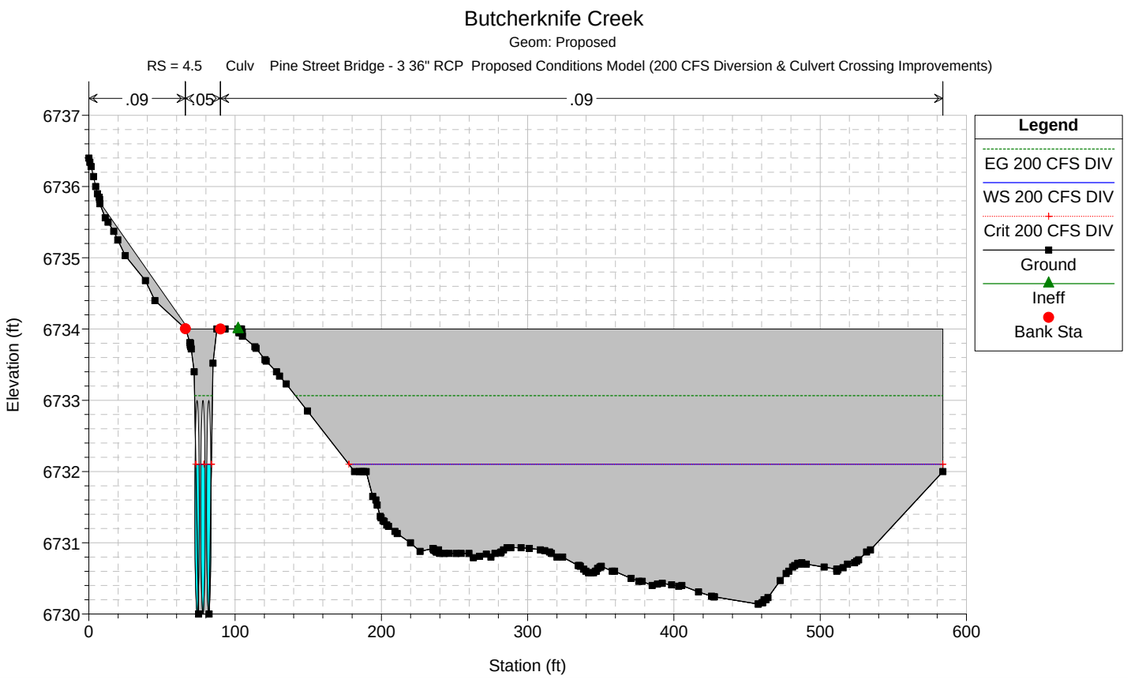

Butcherknife Creek
Geom: Proposed
RS = 2.75 Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Bank Sta
Elevation (ft)
Station (ft)

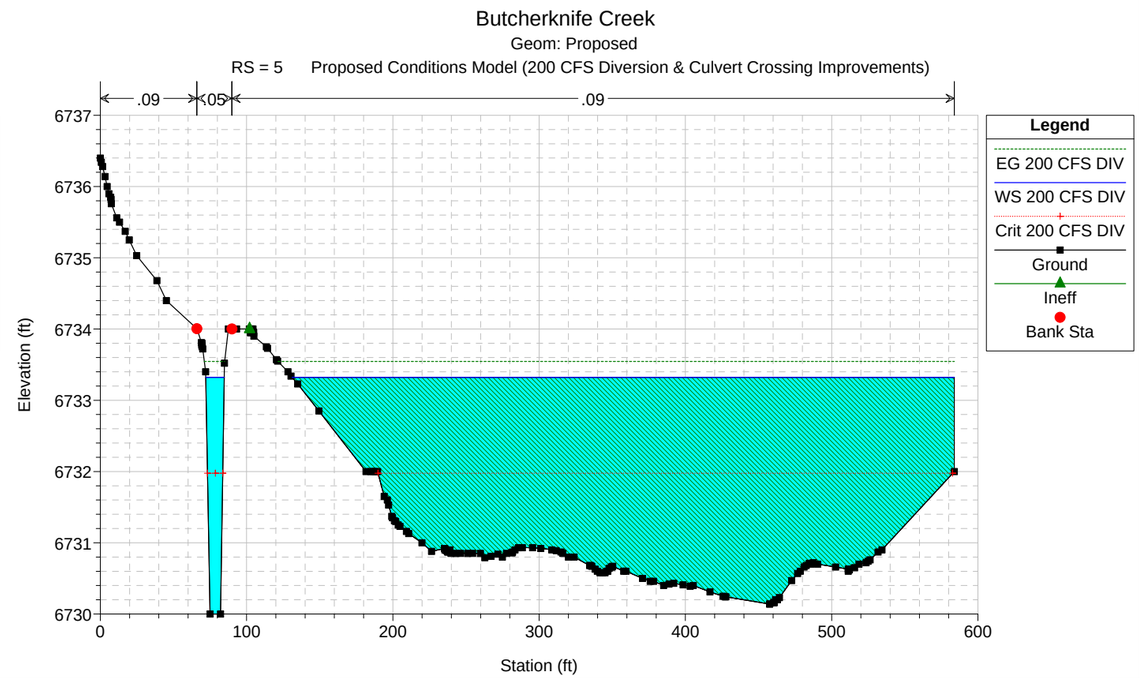

Butcherknife Creek
Geom: Proposed
RS = 3 Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

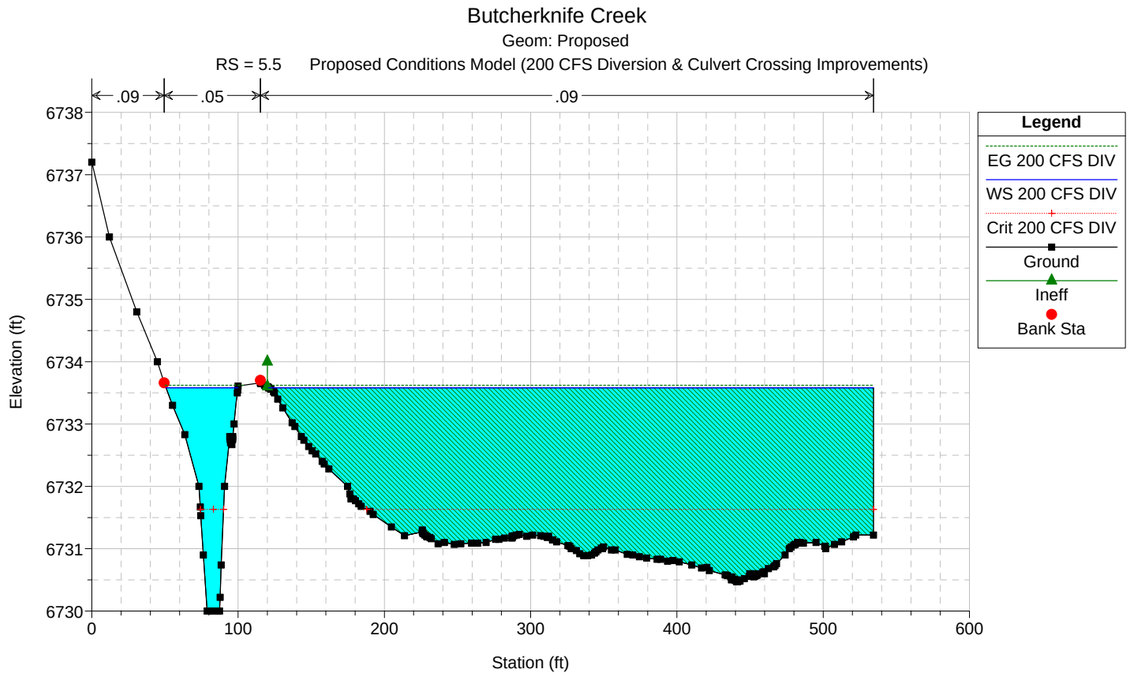

Butcherknife Creek
Geom: Proposed
RS = 4 Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Ground
Bank Sta
Elevation (ft)
Station (ft)

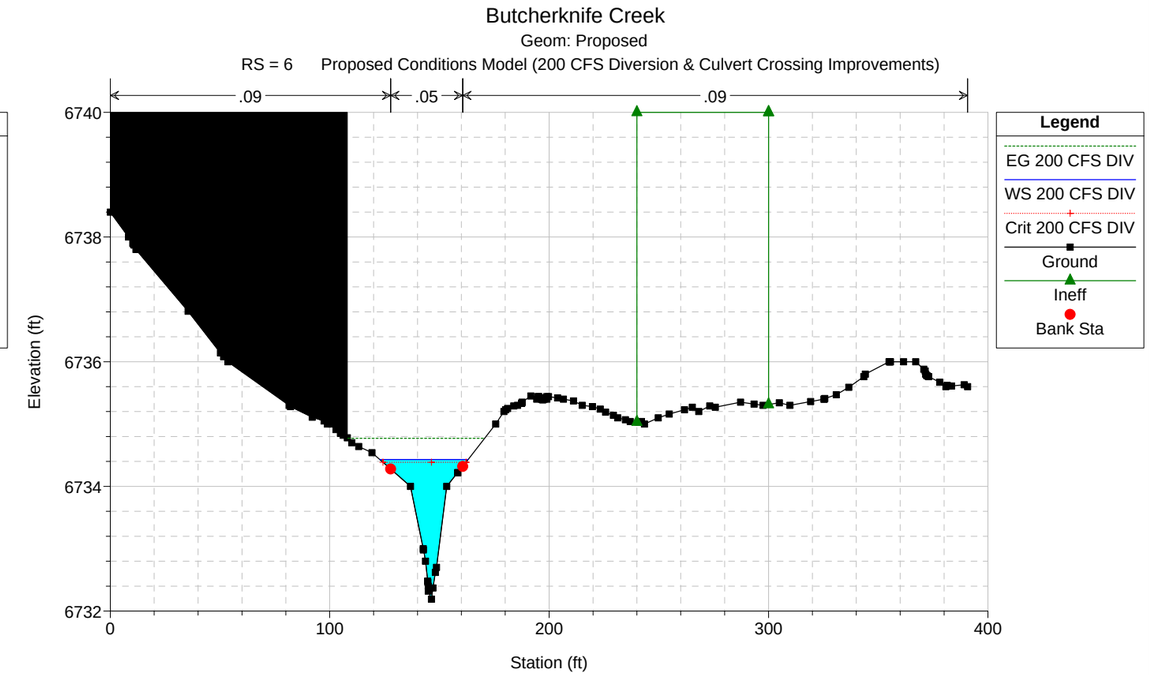

Butcherknife Creek
Geom: Proposed
RS = 4.25 Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Bank Sta
Elevation (ft)
Station (ft)

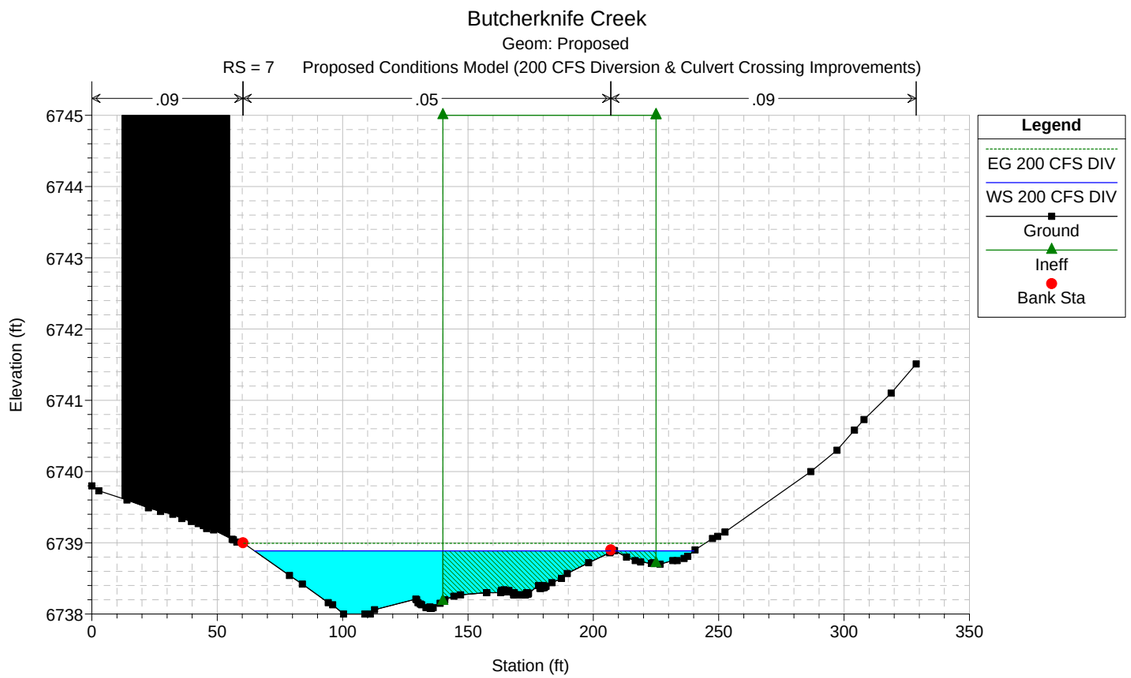

Butcherknife Creek
Geom: Proposed
RS = 4.5 Culv Pine Street Bridge - 3 36" RCP Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
Crit 200 CFS DIV
WS 200 CFS DIV
Ground
Bank Sta
Elevation (ft)
Station (ft)

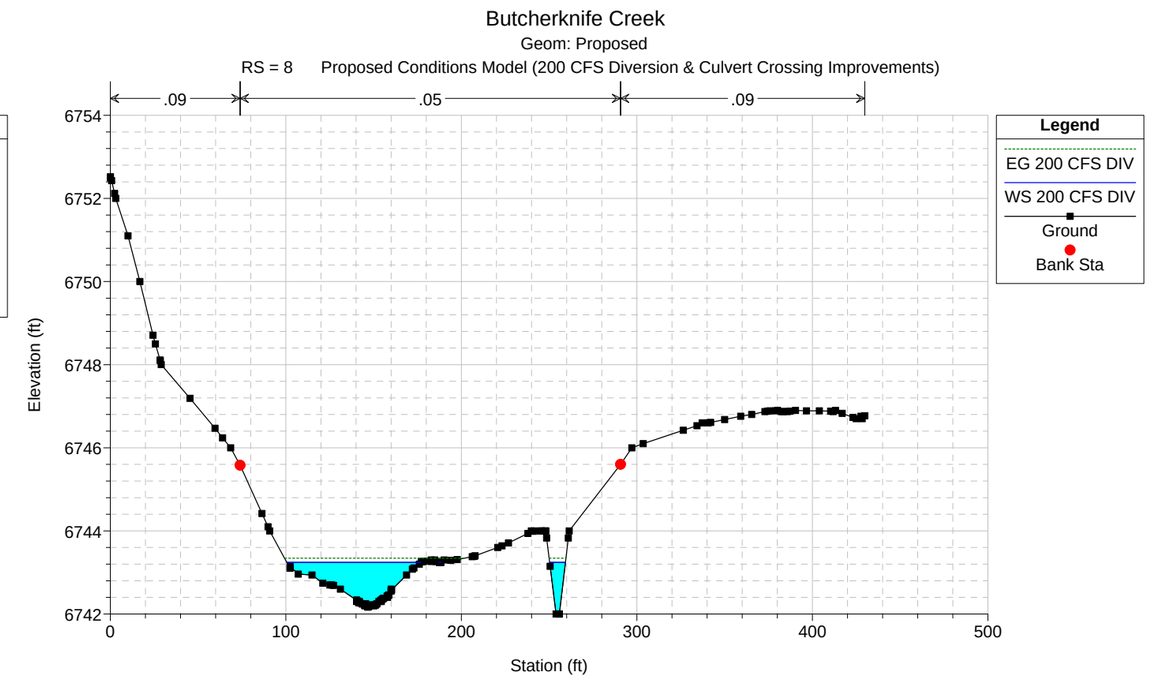

Butcherknife Creek
Geom: Proposed
RS = 4.5 Culv Pine Street Bridge - 3 36" RCP Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

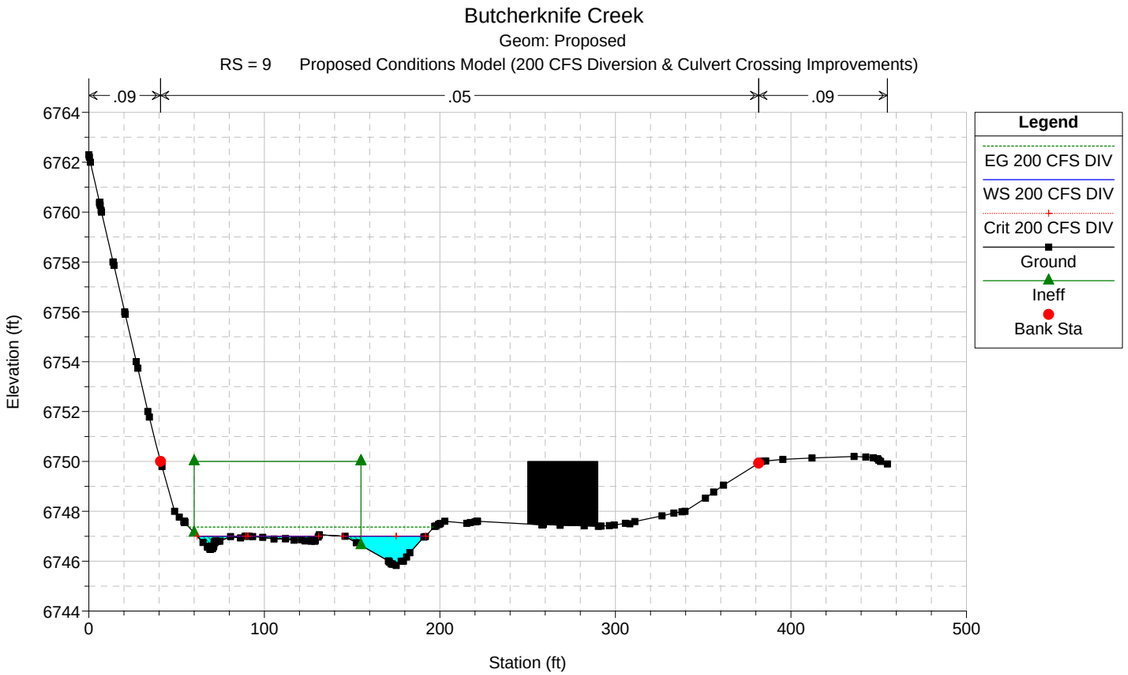

Butcherknife Creek
Geom: Proposed
RS = 5 Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

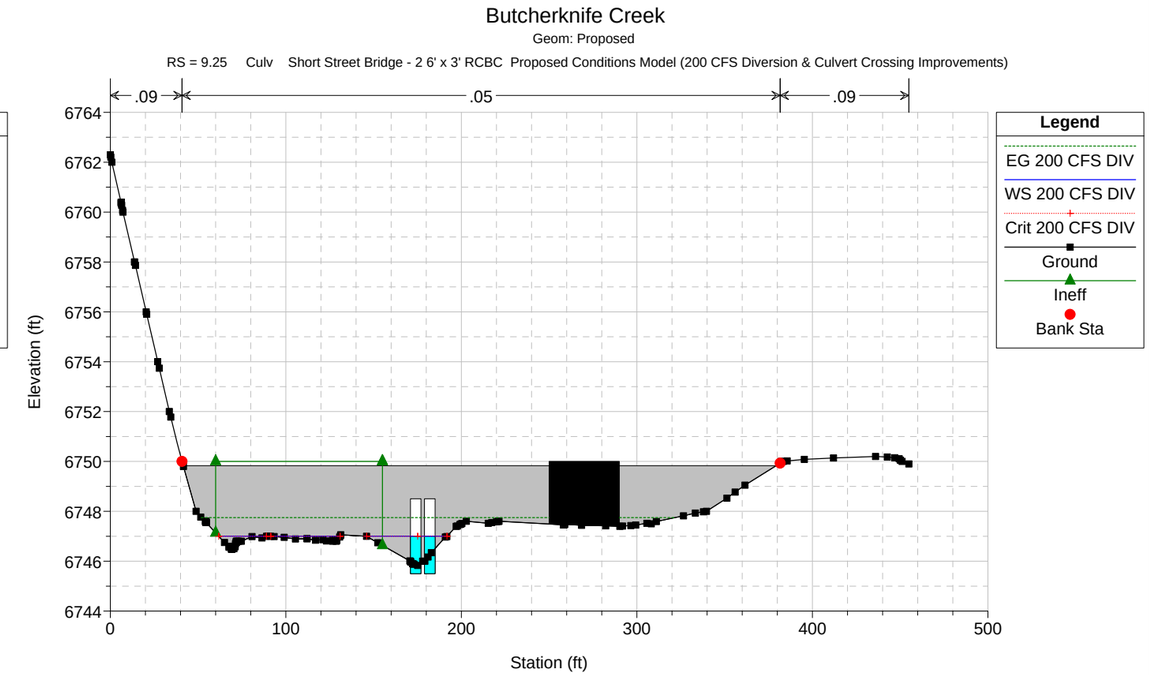

Butcherknife Creek
Geom: Proposed
RS = 5.5 Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

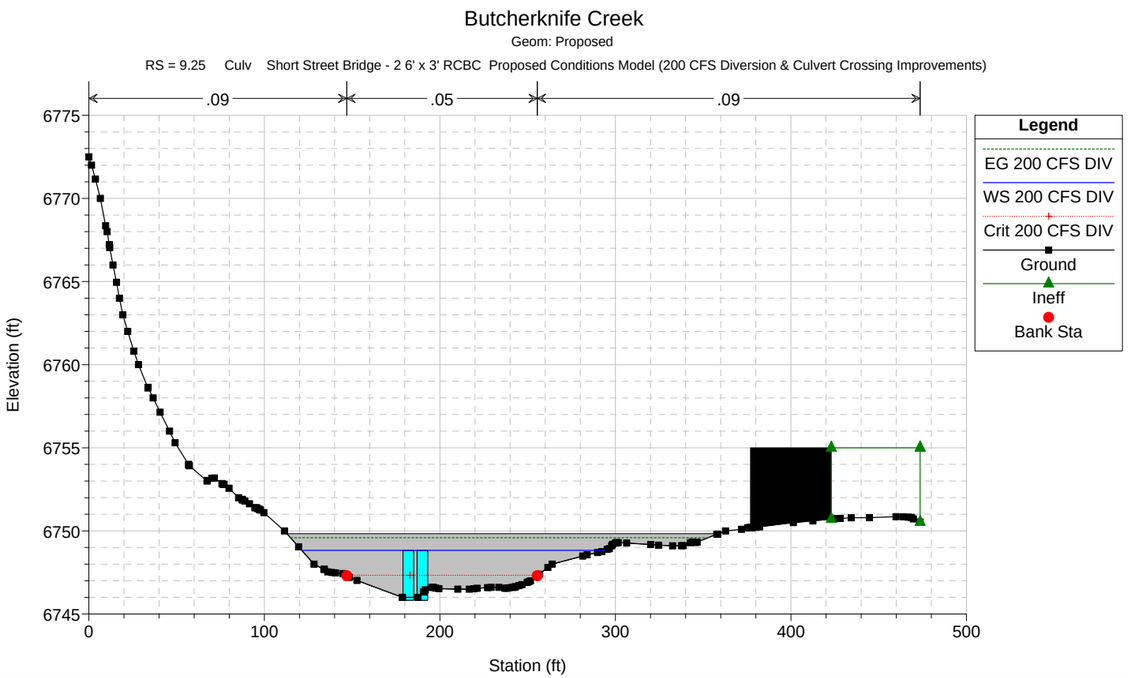

Butcherknife Creek
Geom: Proposed
RS = 6 Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

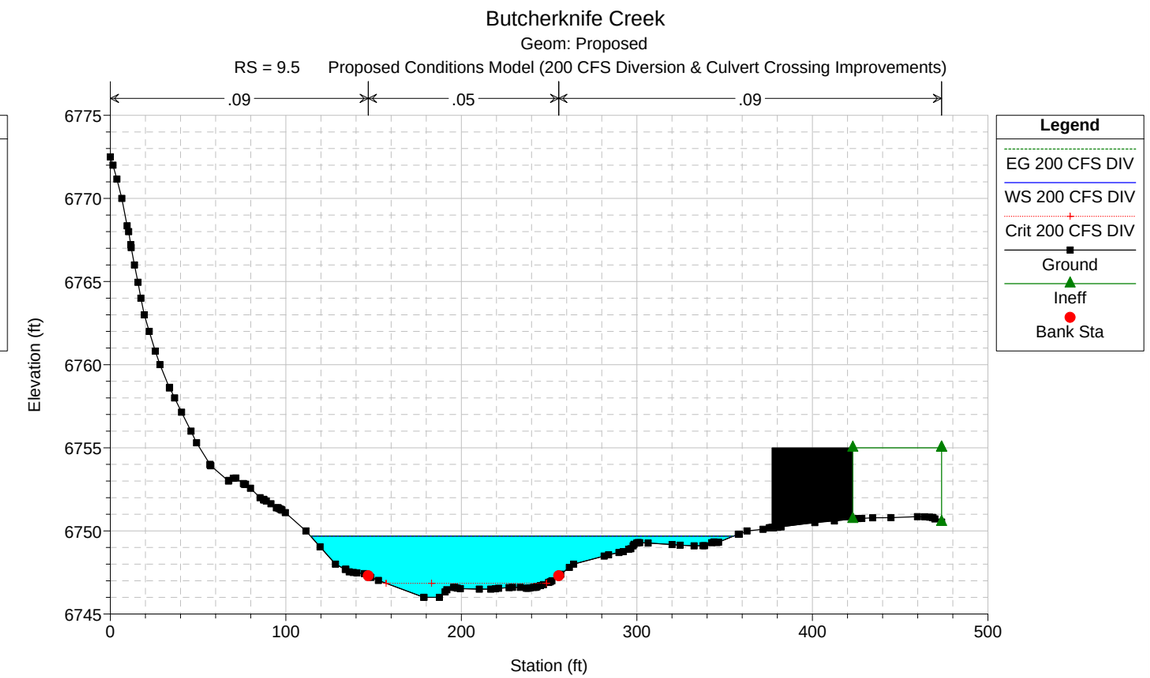

Butcherknife Creek
Geom: Proposed
RS = 7 Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

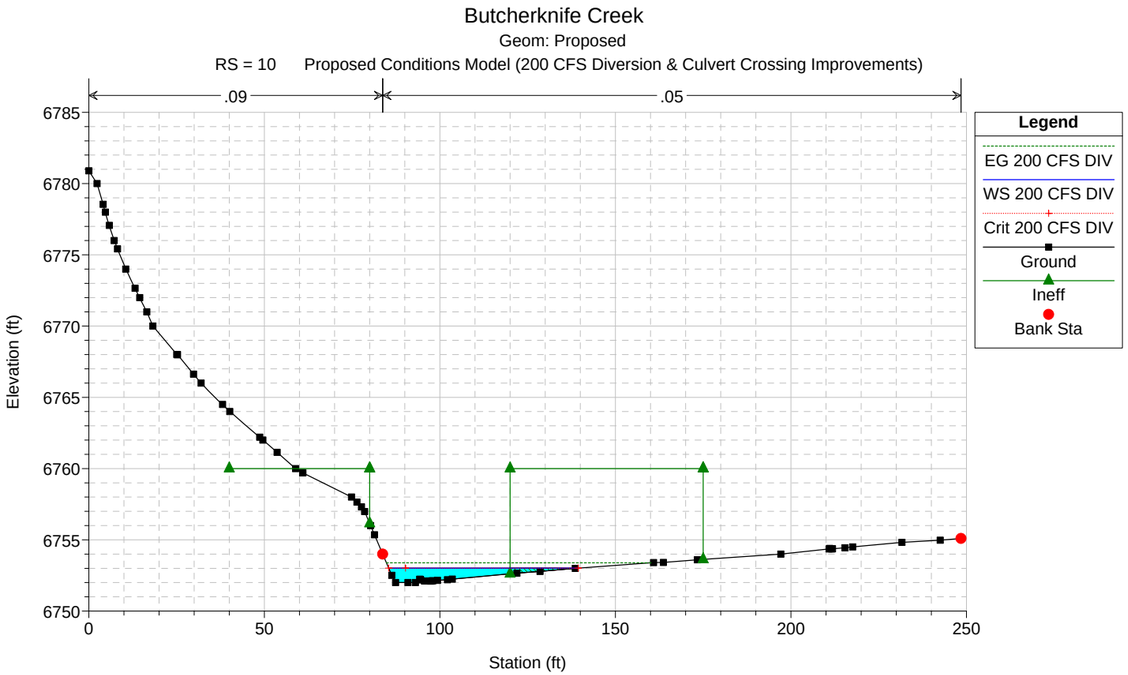

Butcherknife Creek
Geom: Proposed
RS = 8 Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Ground
Bank Sta
Elevation (ft)
Station (ft)

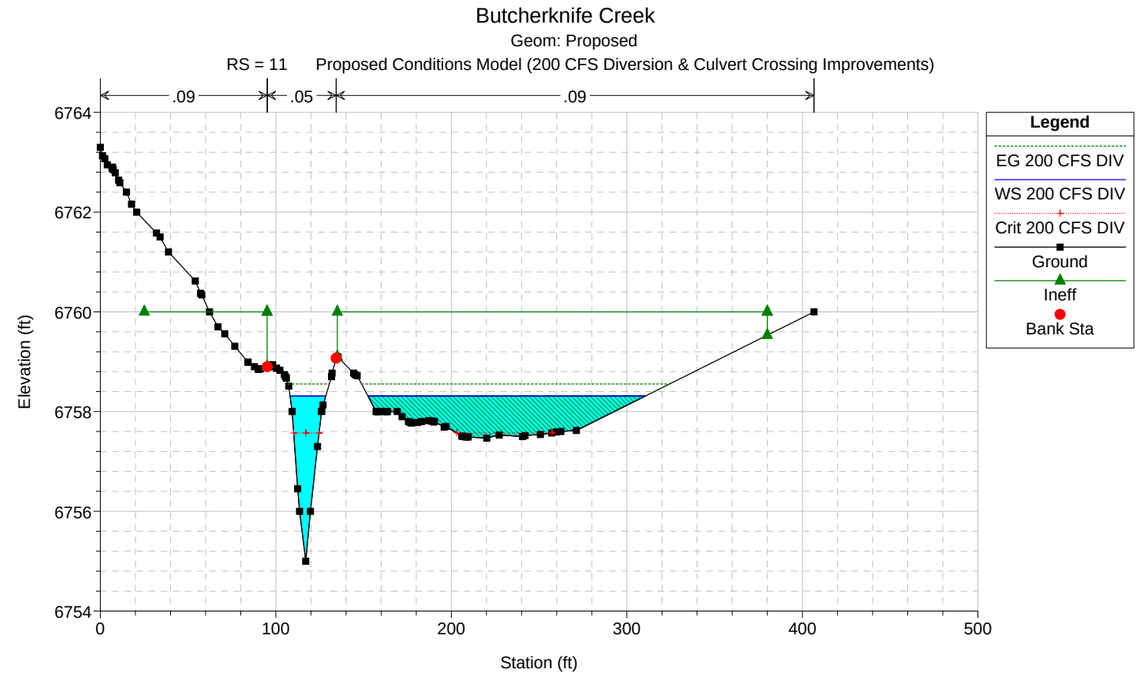

Butcherknife Creek
Geom: Proposed
RS = 9 Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

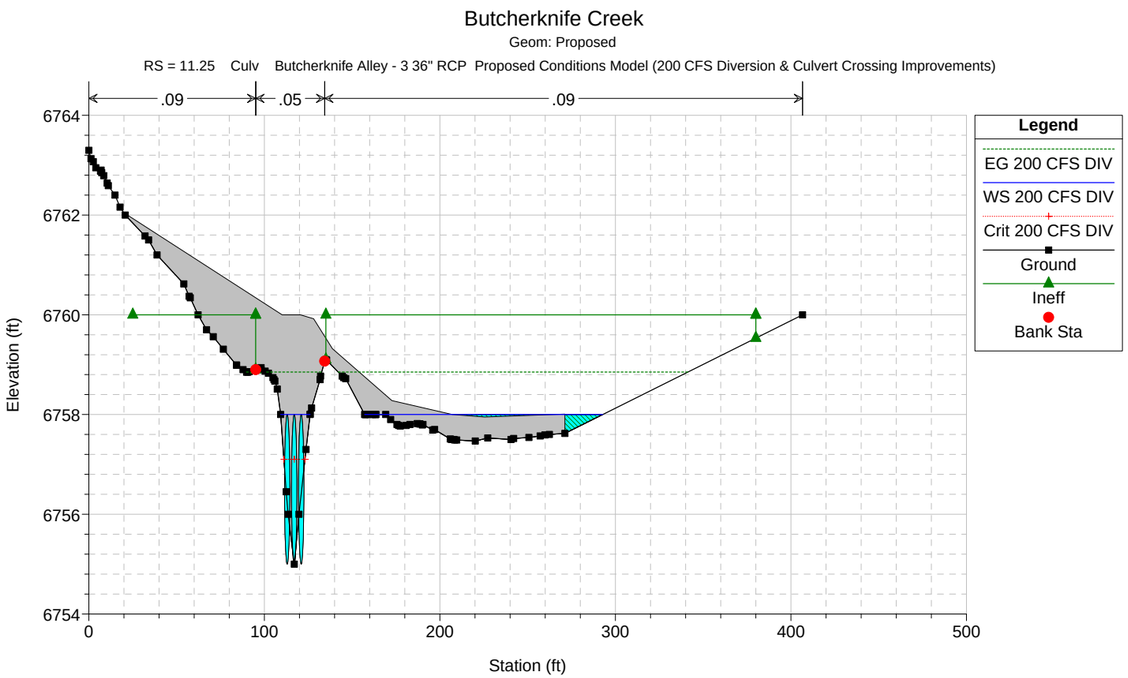

Butcherknife Creek
Geom: Proposed
RS = 9.25 Culv Short Street Bridge - 2 6' x 3' RCBC Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

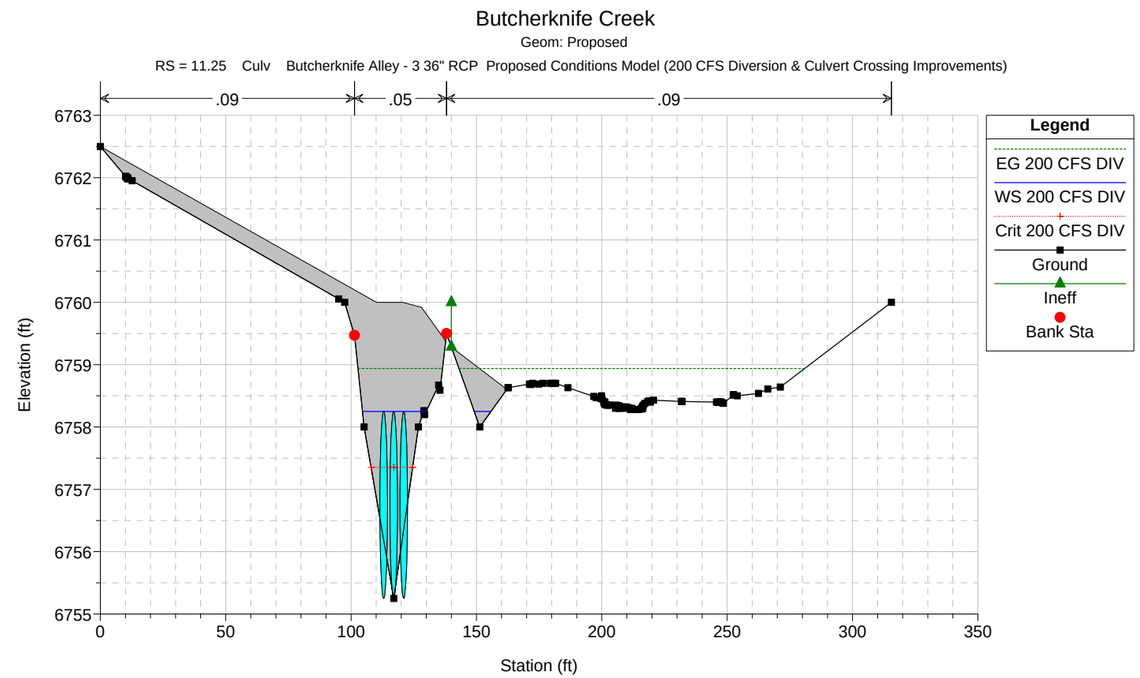

Butcherknife Creek
Geom: Proposed
RS = 9.25 Culv Short Street Bridge - 2 6' x 3' RCBC Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

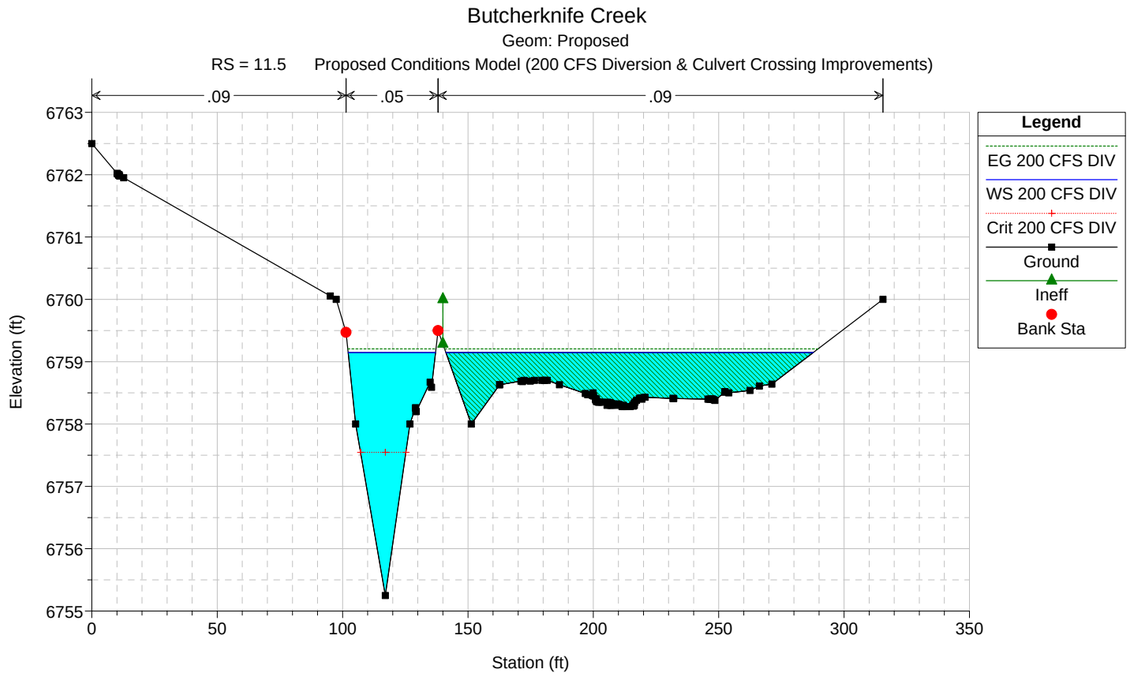

Butcherknife Creek
Geom: Proposed
RS = 9.5 Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

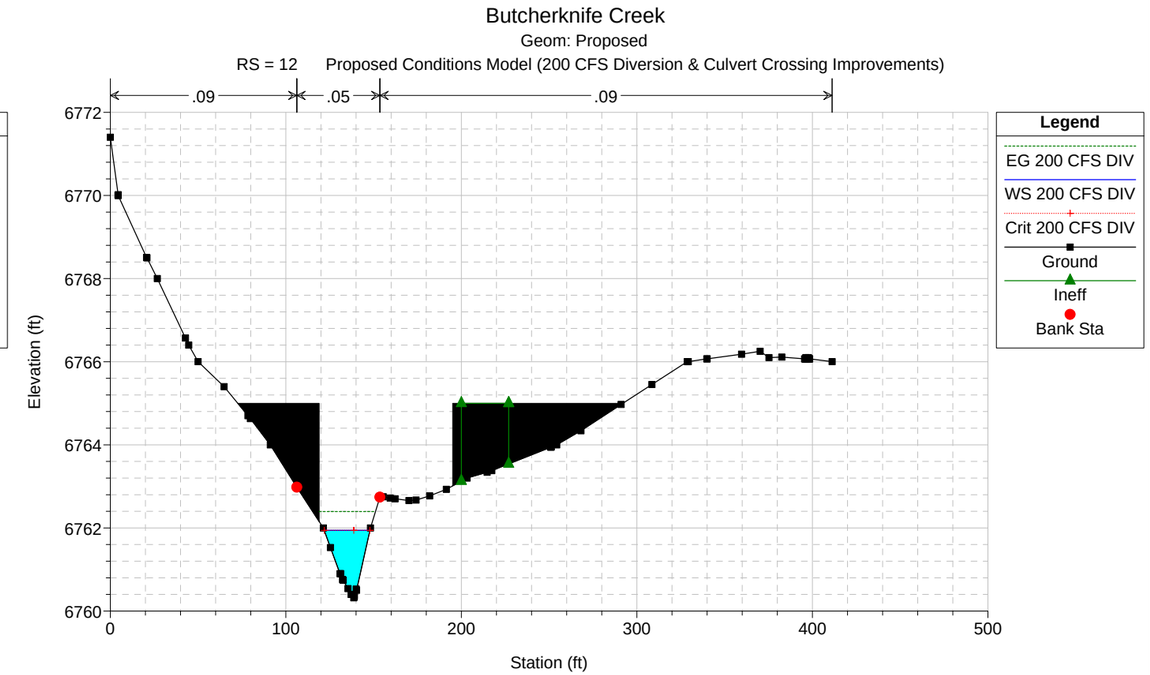

Butcherknife Creek
Geom: Proposed
RS = 10 Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
Elevation (ft)
Station (ft)
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Ineff
Bank Sta

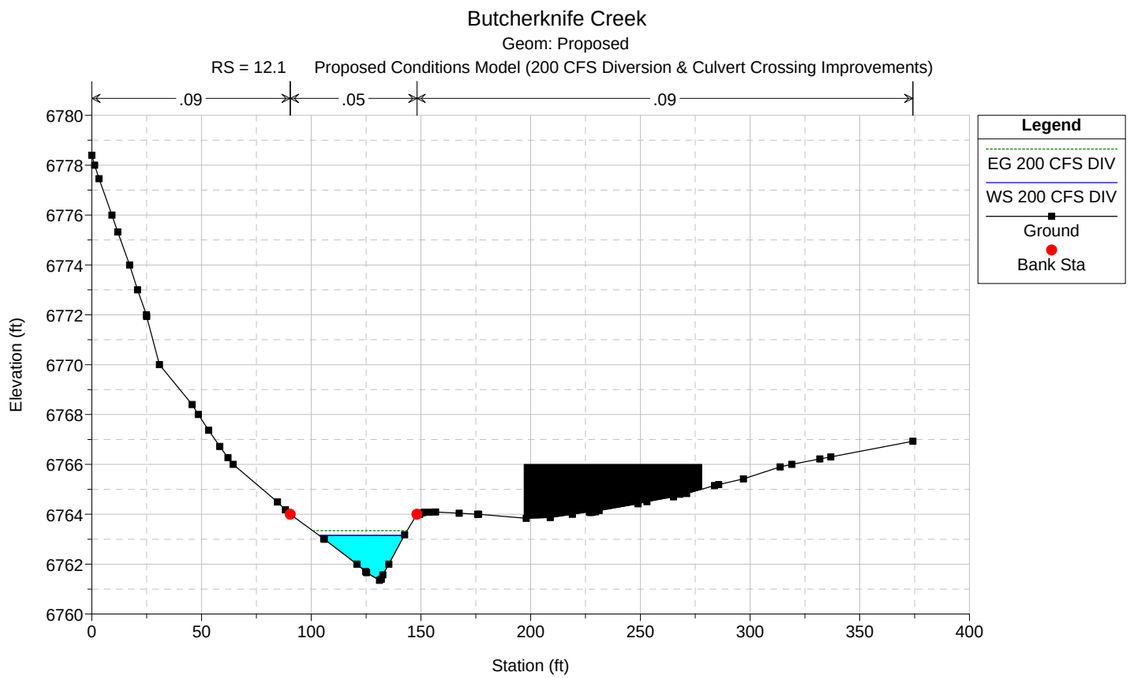

Butcherknife Creek
Geom: Proposed
RS = 11 Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Elevation (ft)
Station (ft)
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Ineff
Bank Sta

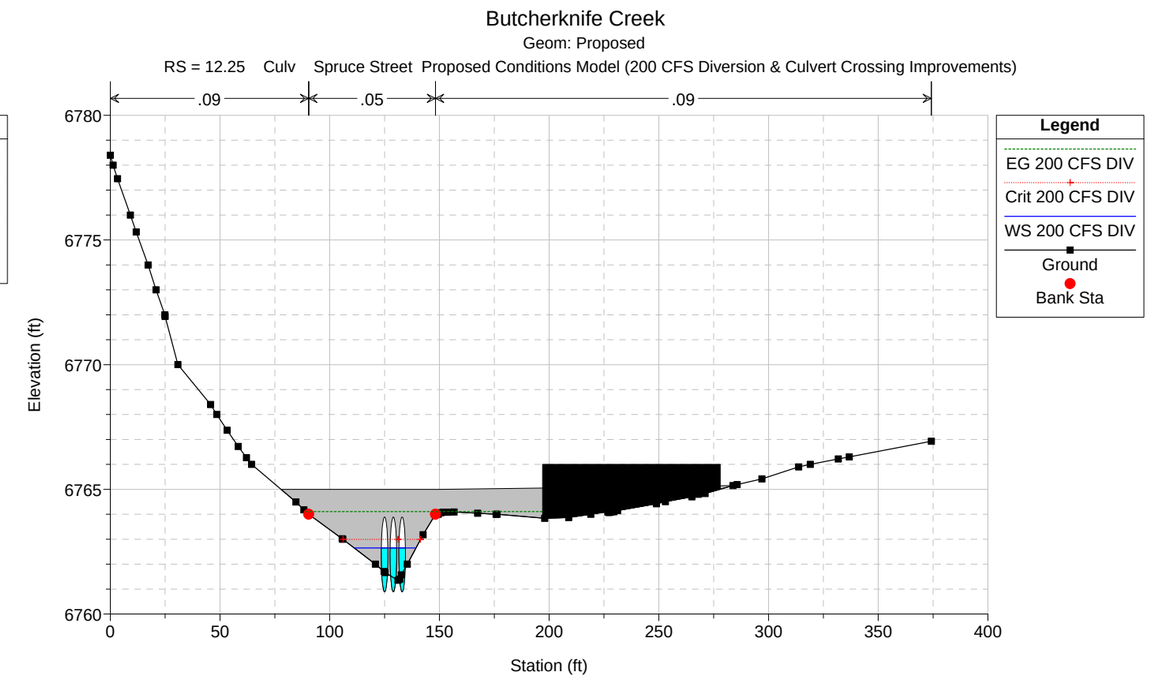

Butcherknife Creek
Geom: Proposed
RS = 11.25 Culv Butcherknife Alley - 3 36" RCP Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Elevation (ft)
Station (ft)
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Ineff
Bank Sta

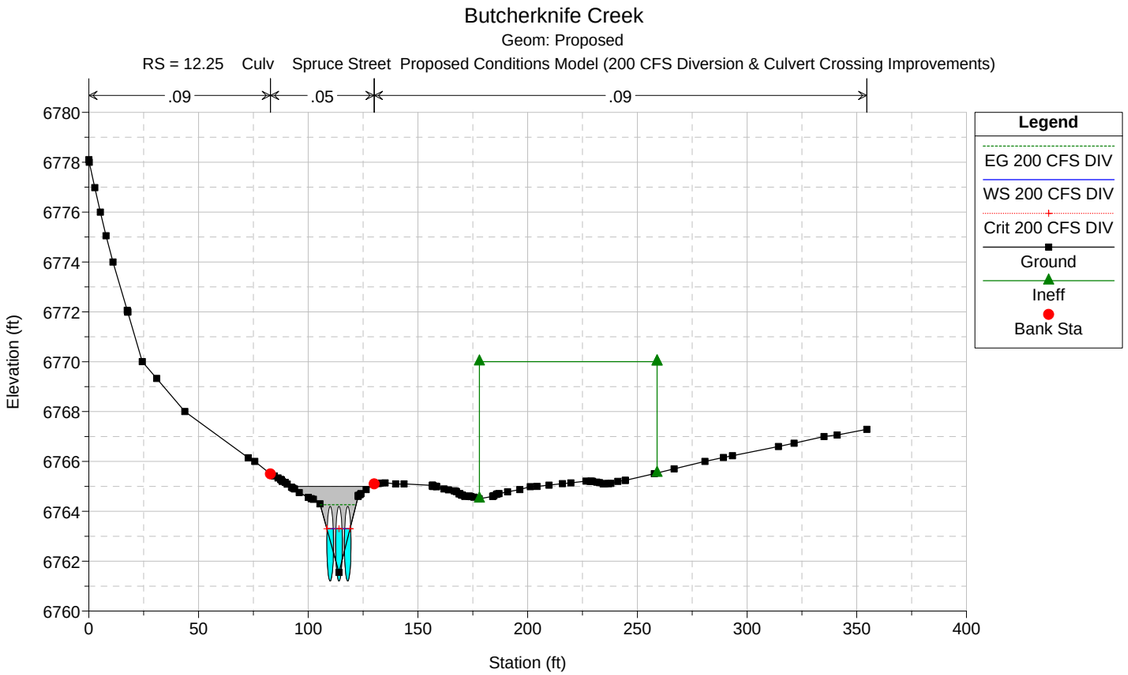

Butcherknife Creek
Geom: Proposed
RS = 11.25 Culv Butcherknife Alley - 3 36" RCP Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Elevation (ft)
Station (ft)
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Ineff
Bank Sta

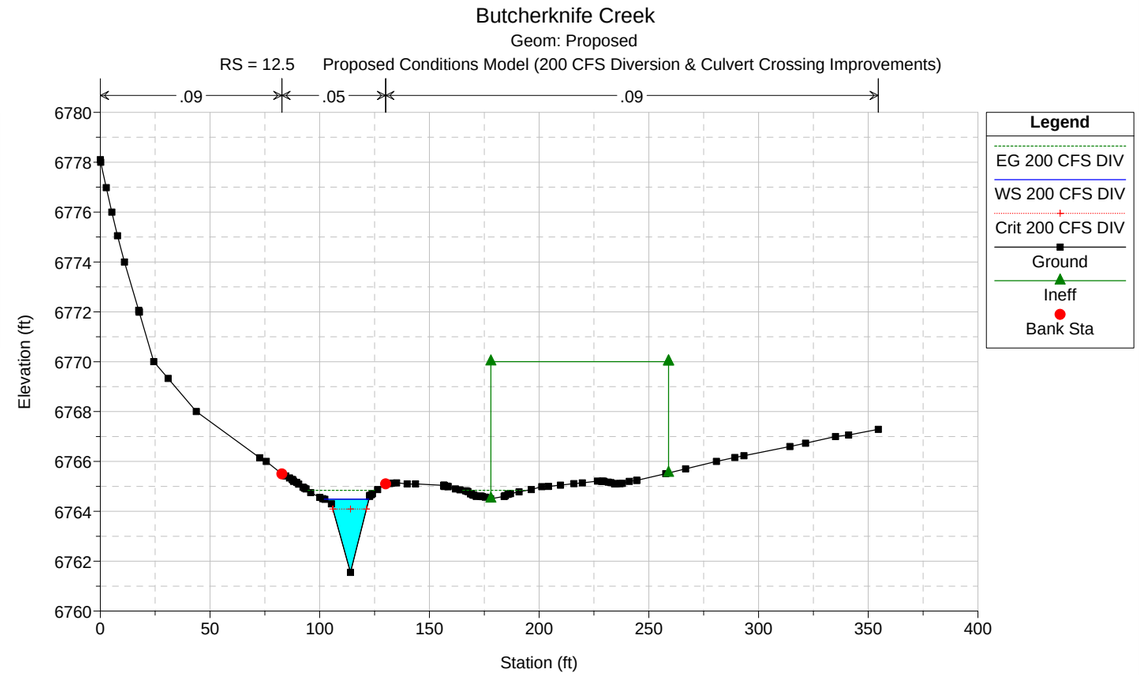

Butcherknife Creek
Geom: Proposed
RS = 11.5 Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

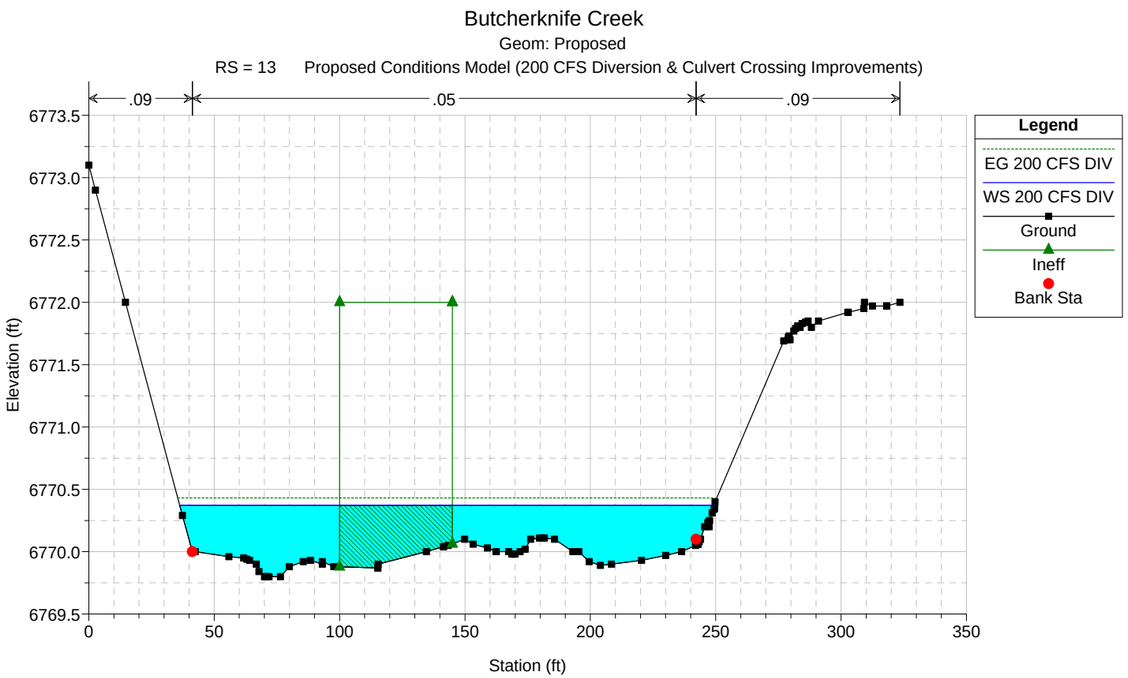

Butcherknife Creek
Geom: Proposed
RS = 12 Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

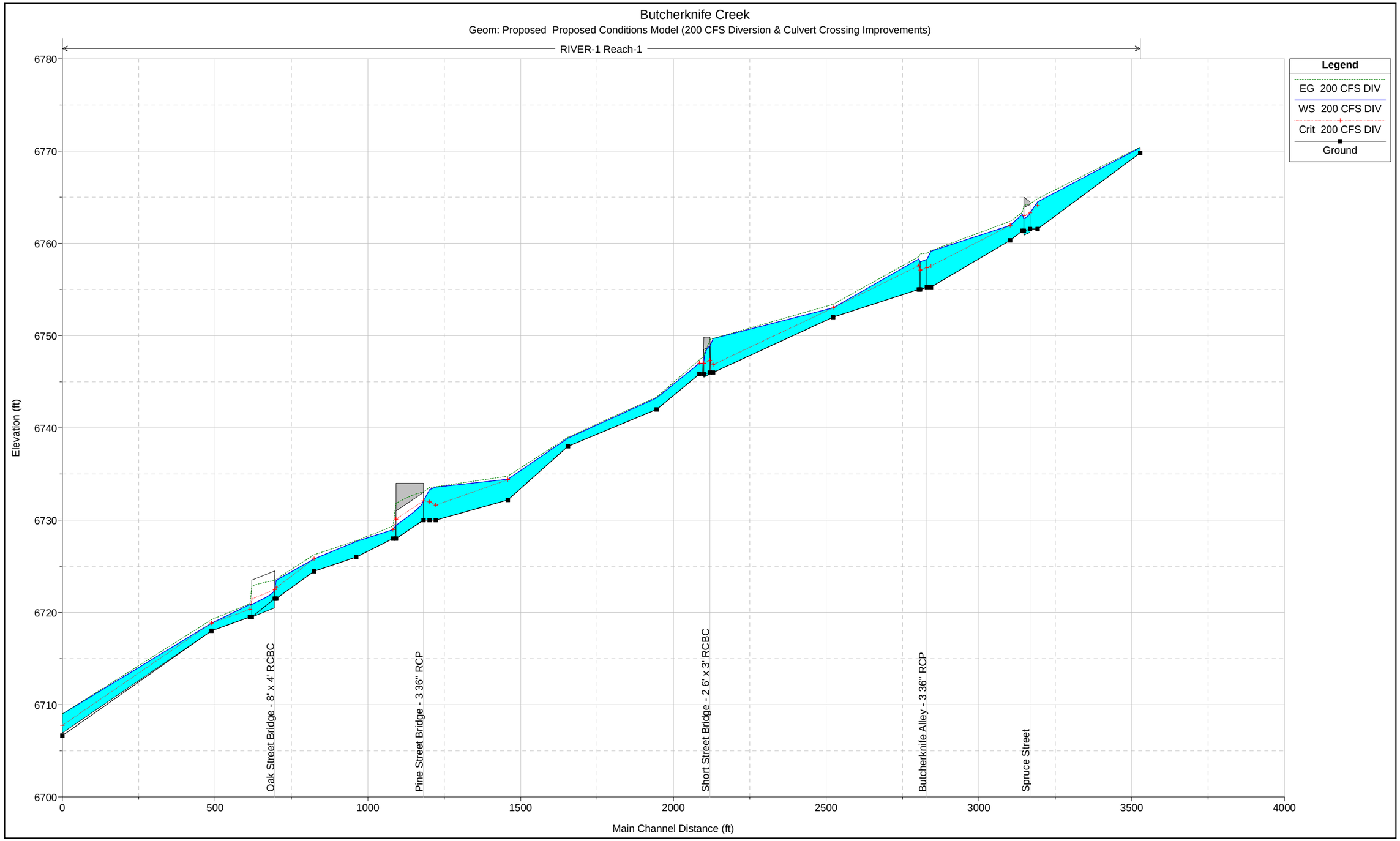

Butcherknife Creek
Geom: Proposed
RS = 12.1 Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Ground
Bank Sta
Elevation (ft)
Station (ft)


Butcherknife Creek
Geom: Proposed
RS = 12.25 Culv Spruce Street Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
Crit 200 CFS DIV
WS 200 CFS DIV
Ground
Bank Sta
Elevation (ft)
Station (ft)


Butcherknife Creek
Geom: Proposed
RS = 12.25 Culv Spruce Street Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Butcherknife Creek
Geom: Proposed
RS = 12.5 Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

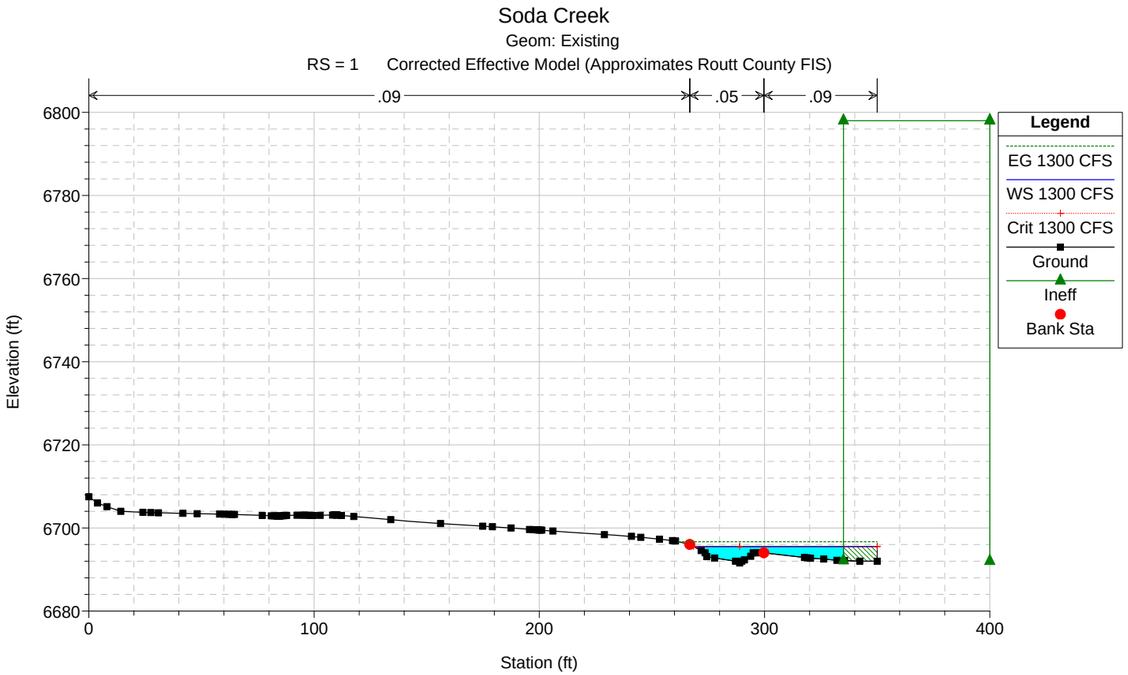

Butcherknife Creek
Geom: Proposed
RS = 13 Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
.09
.05
.09
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

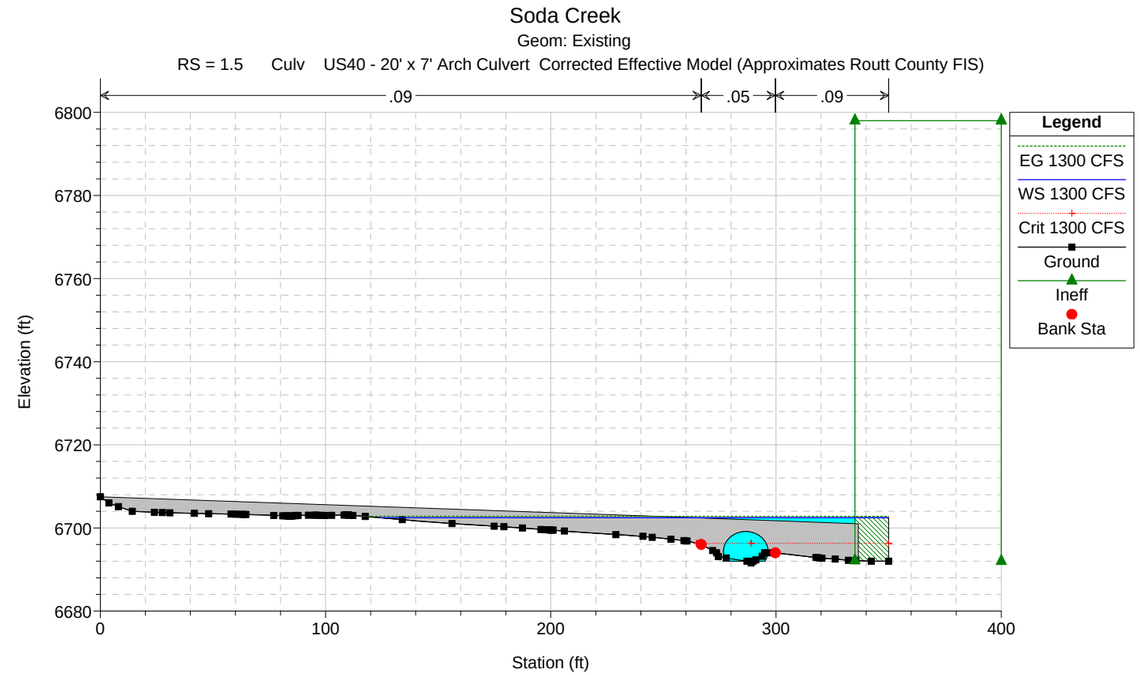

Butcherknife Creek
Geom: Proposed Proposed Conditions Model (200 CFS Diversion & Culvert Crossing Improvements)
RIVER-1 Reach-1
Legend
EG 200 CFS DIV
WS 200 CFS DIV
Crit 200 CFS DIV
Ground
Elevation (ft)
6780
6770
6760
6750
6740
6730
6720
6710
6700
0
500
1000
1500
2000
2500
3000
3500
4000
Main Channel Distance (ft)
Oak Street Bridge - 8' x 4' RCBC
Pine Street Bridge - 3 36" RCP
Short Street Bridge - 2 6' x 3' RCBC
Butcherknife Alley - 3 36" RCP
Spruce Street

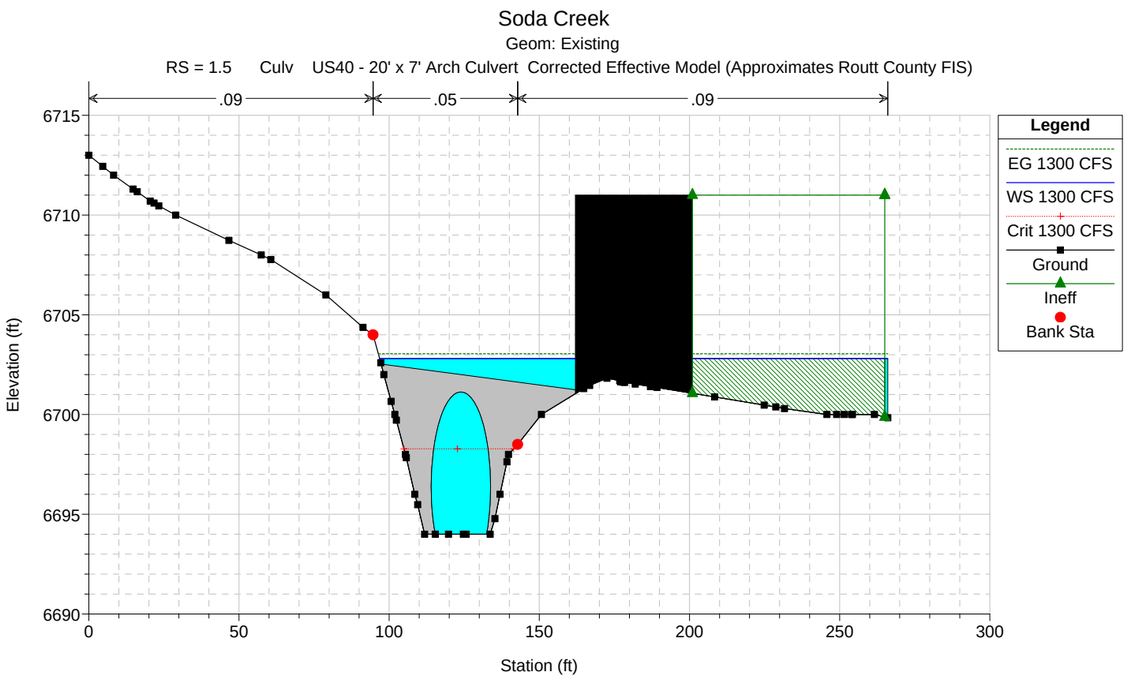
HEC-RAS OUTPUT FOR SODA CREEK – CORRECTED EFFECTIVE MODEL

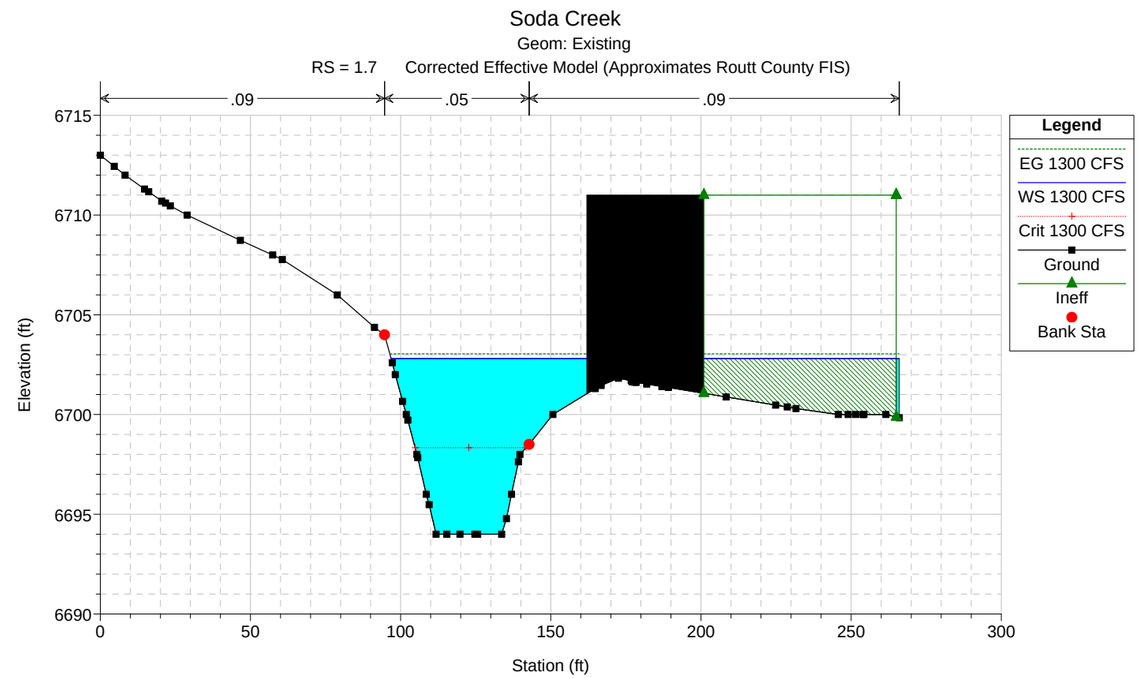
Soda Creek - Corrected Effective Model (Approximates Routt County FIS)

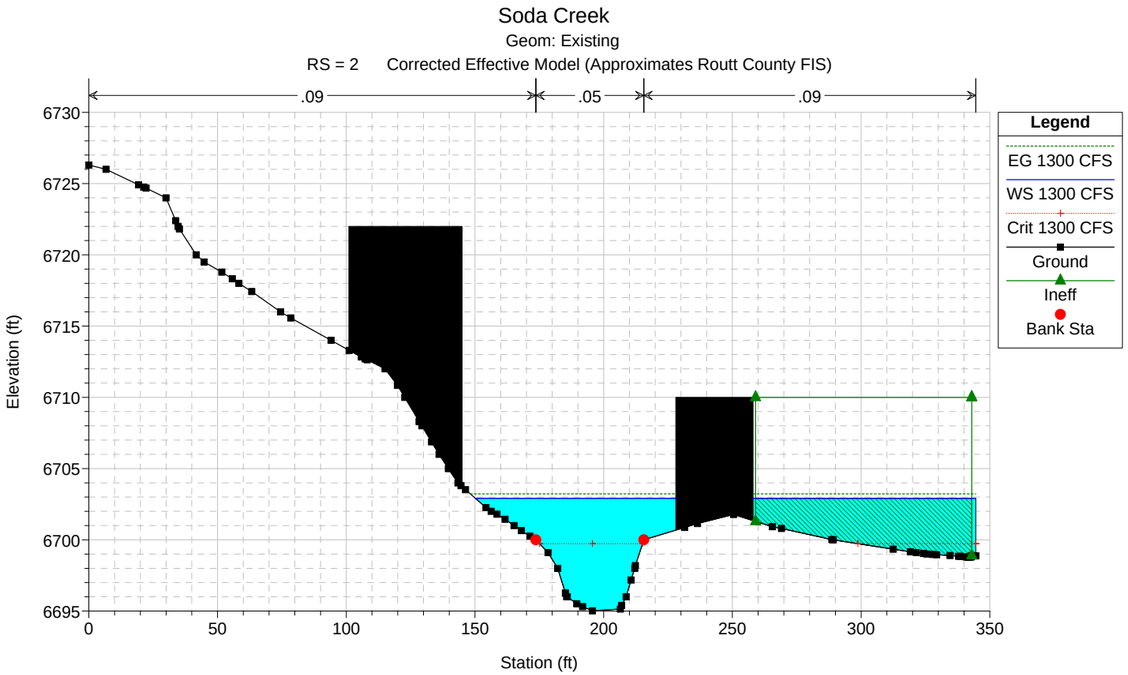
Reach	River Sta	Flood Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Soda Creek	19	1300 CFS	1300	6752	6755.42		6755.78	0.00864	5.01	323.5	254.5	0.56
Soda Creek	18	1300 CFS	1300	6750	6752.85		6753.23	0.01120	4.99	282.0	191.6	0.62
Soda Creek	17	1300 CFS	1300	6746	6750.22	6749.66	6750.85	0.01280	6.49	227.1	167.2	0.69
Soda Creek	16	1300 CFS	1300	6741.5	6746.1	6745.19	6746.97	0.01170	7.47	174.1	46.9	0.68
Soda Creek	15	1300 CFS	1300	6738.94	6742.85	6742.85	6743.85	0.01863	8.21	197.5	151.2	0.85
Soda Creek	14	1300 CFS	1300	6736	6740.88		6741.30	0.00809	5.74	368.8	286.5	0.56
Soda Creek	13	1300 CFS	1300	6732.74	6736.86	6736.46	6737.73	0.01649	7.53	177.3	76.2	0.79
Soda Creek	12	1300 CFS	1300	6728.88	6732.66		6732.99	0.00798	5.35	409.0	308.5	0.55
Soda Creek	11	1300 CFS	1300	6725.55	6728.96	6728.96	6729.55	0.02360	7.56	288.1	222.8	0.9
Soda Creek	10	1300 CFS	1300	6719.01	6725.02		6725.29	0.00322	4.23	322.2	118.4	0.37
Soda Creek	9.5	1300 CFS	1300	6716.98	6722.06	6722.06	6724.27	0.02938	11.93	108.9	24.8	1
Soda Creek	9	1300 CFS	1300	6713.62	6718.41	6718.41	6720.08	0.02556	10.36	125.5	36.8	0.99
Soda Creek	8	1300 CFS	1300	6710	6716.06	6714.34	6716.52	0.00559	5.63	302.3	193.7	0.48
Soda Creek	7.5		Bridge									
Soda Creek	7	1300 CFS	1300	6707.78	6712.65	6712.65	6713.99	0.02772	9.28	140.1	53.0	1.01
Soda Creek	6	1300 CFS	1300	6704.89	6711.79	6709.91	6712.10	0.00358	5.13	468.7	367.0	0.4
Soda Creek	5	1300 CFS	1300	6704	6710.18	6709.73	6711.03	0.01176	7.89	234.5	262.4	0.68
Soda Creek	4.6		Culvert									
Soda Creek	4.4	1300 CFS	1300	6702	6709.44	6706.12	6709.85	0.00256	5.17	272.4	123.1	0.35
Soda Creek	4.2		Culvert									
Soda Creek	4	1300 CFS	1300	6699.59	6705.26	6705.26	6707.22	0.02290	11.34	127.1	43.5	0.93
Soda Creek	3	1300 CFS	1300	6696	6703.17		6703.90	0.00757	7.02	220.7	80.6	0.55
Soda Creek	2	1300 CFS	1300	6695.02	6702.92	6699.73	6703.23	0.00224	4.63	338.0	164.4	0.33
Soda Creek	1.7	1300 CFS	1300	6694	6702.81	6698.34	6703.04	0.00152	3.95	369.7	130.2	0.27
Soda Creek	1.5		Culvert									
Soda Creek	1	1300 CFS	1300	6691.59	6695.53	6695.53	6696.69	0.03793	10.11	165.2	81.5	1.15

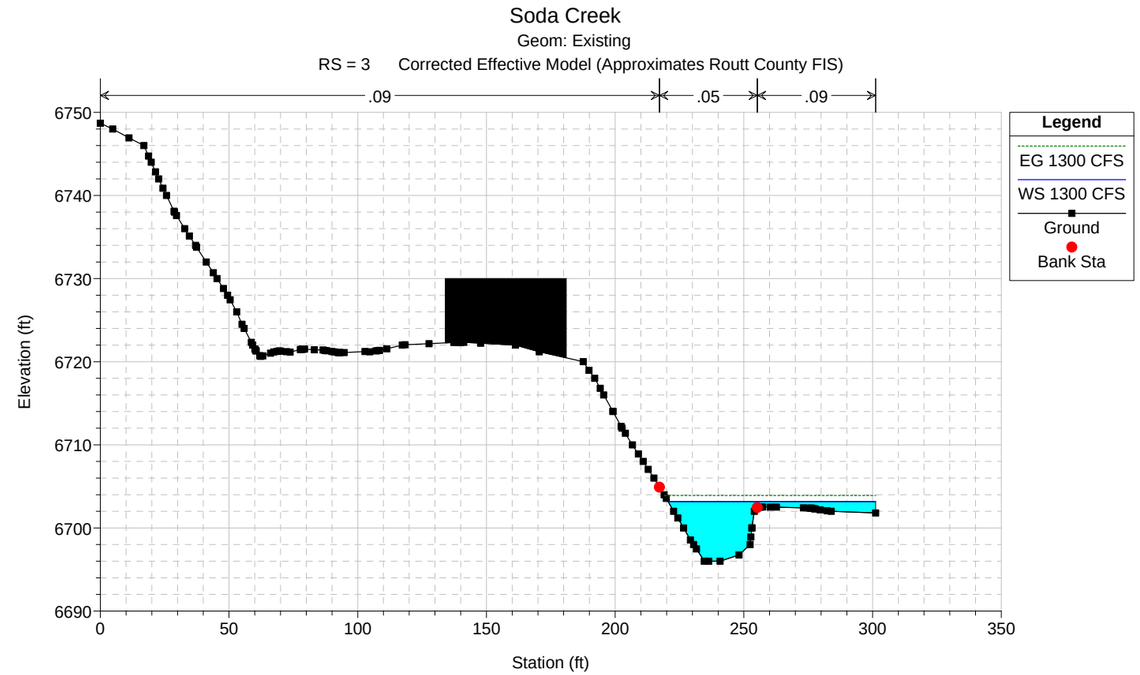

Soda Creek
Geom: Existing
RS = 1 Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

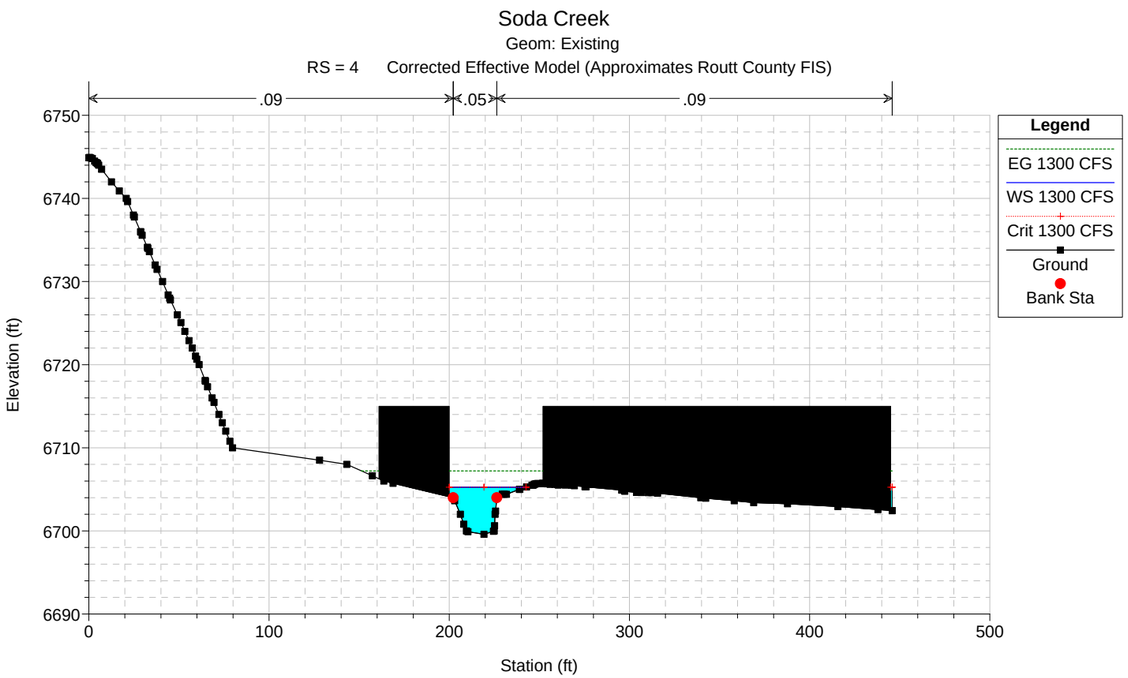

Soda Creek
Geom: Existing
RS = 1.5 Culv US40 - 20' x 7' Arch Culvert Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

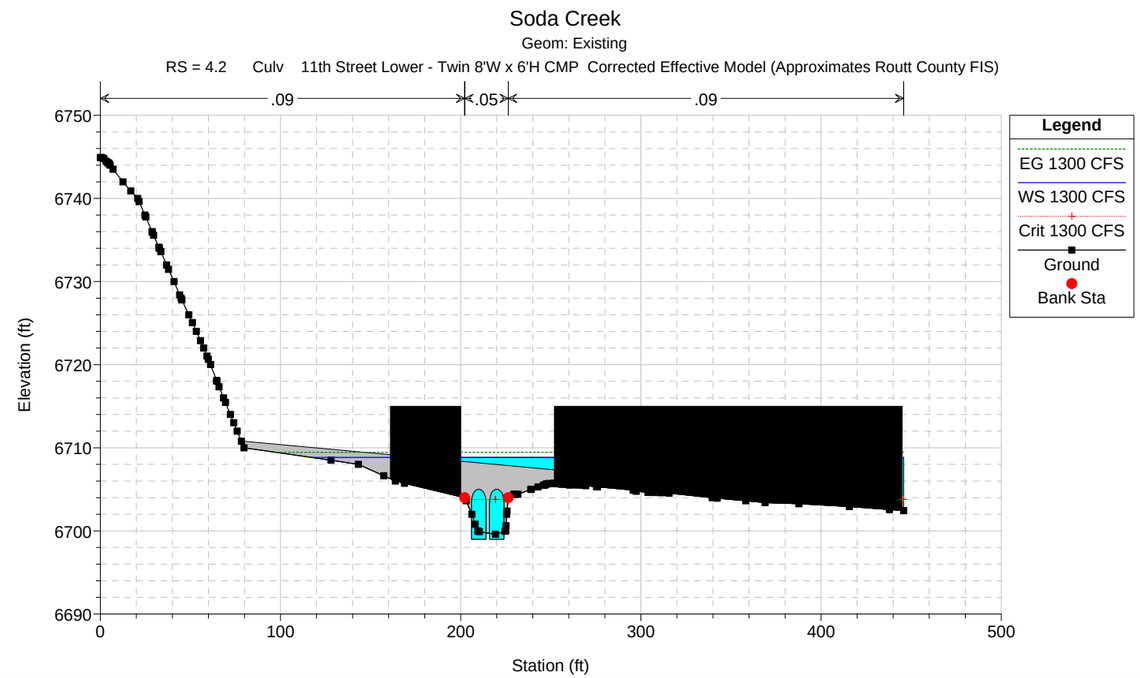

Soda Creek
Geom: Existing
RS = 1.5 Culv US40 - 20' x 7' Arch Culvert Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

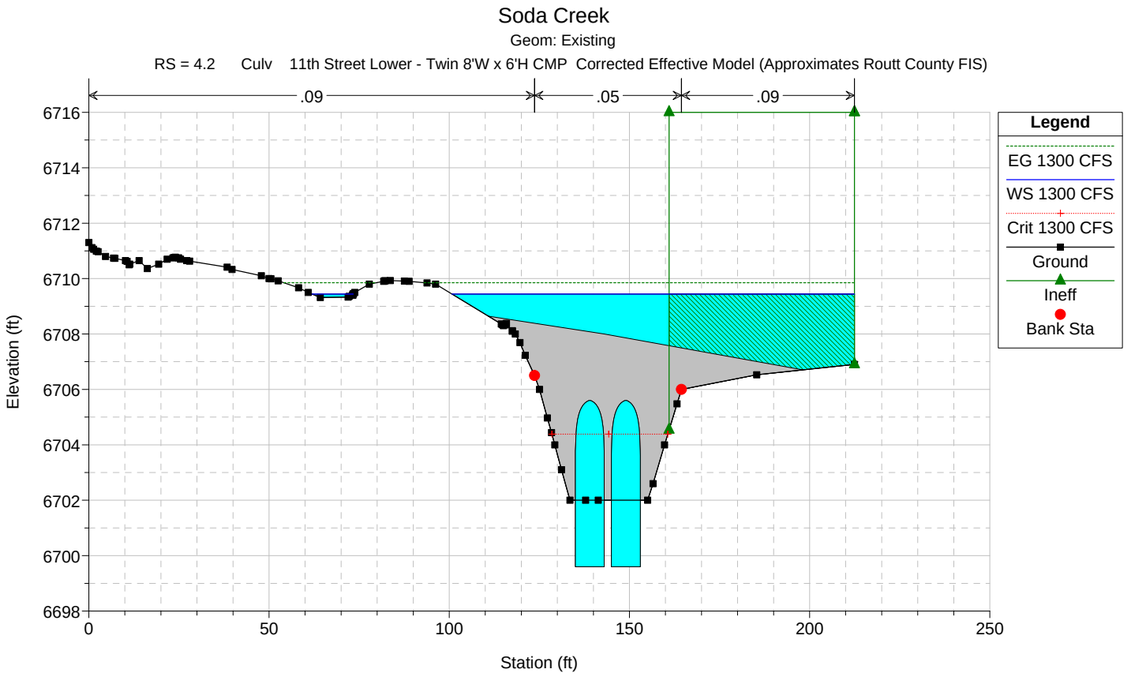

Soda Creek
Geom: Existing
RS = 1.7 Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

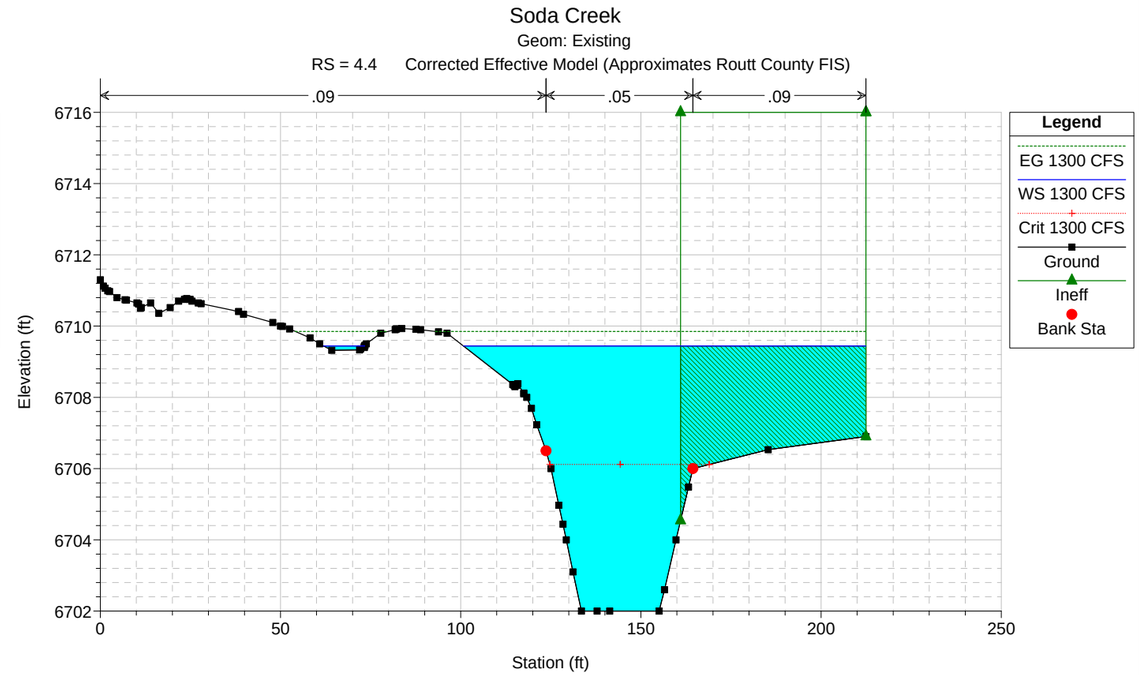

Soda Creek
Geom: Existing
RS = 2 Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

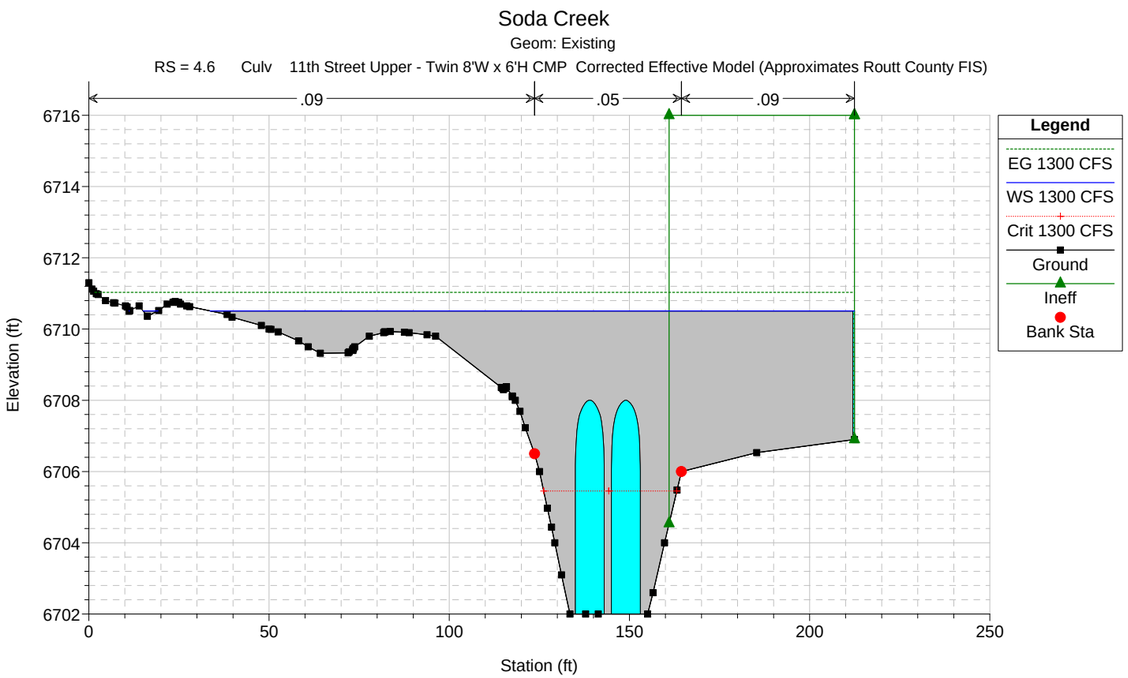

Soda Creek
Geom: Existing
RS = 3 Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)

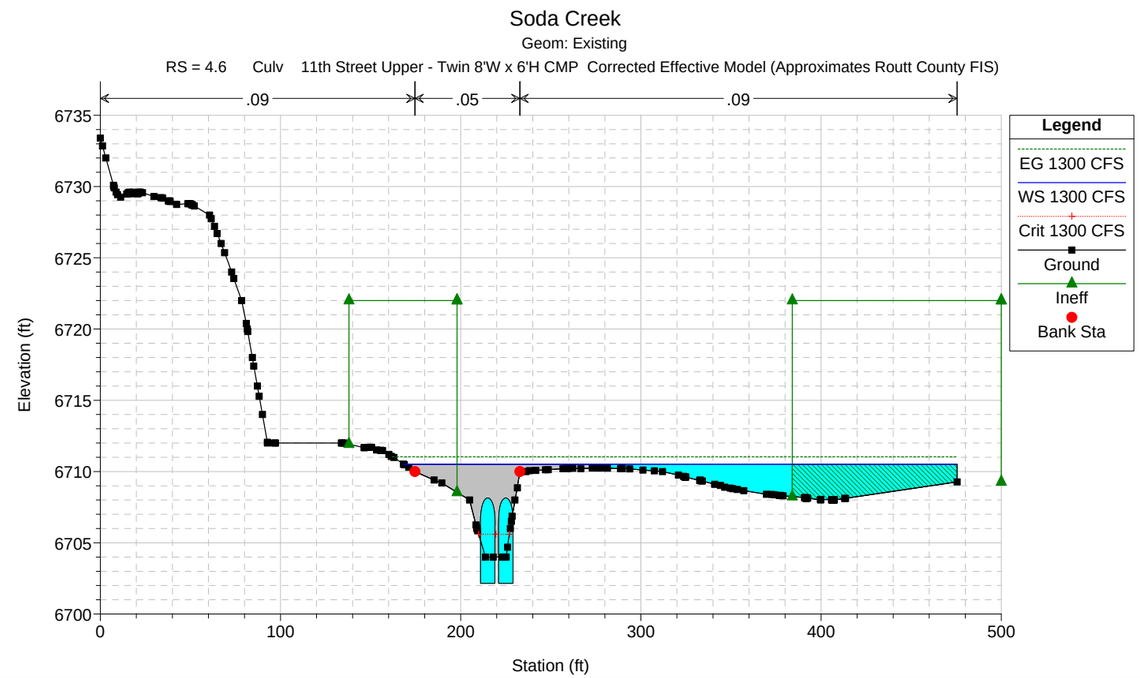

Soda Creek
Geom: Existing
RS = 4 Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)

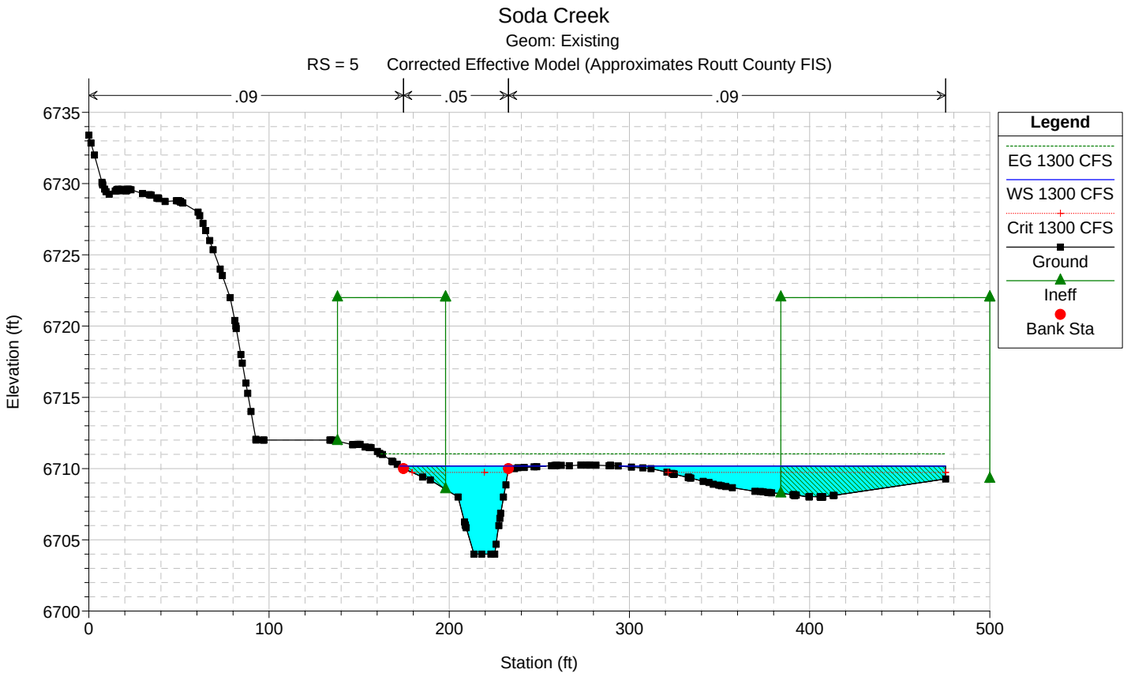

Soda Creek
Geom: Existing
RS = 4.2 Culv 11th Street Lower - Twin 8'W x 6'H CMP Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)

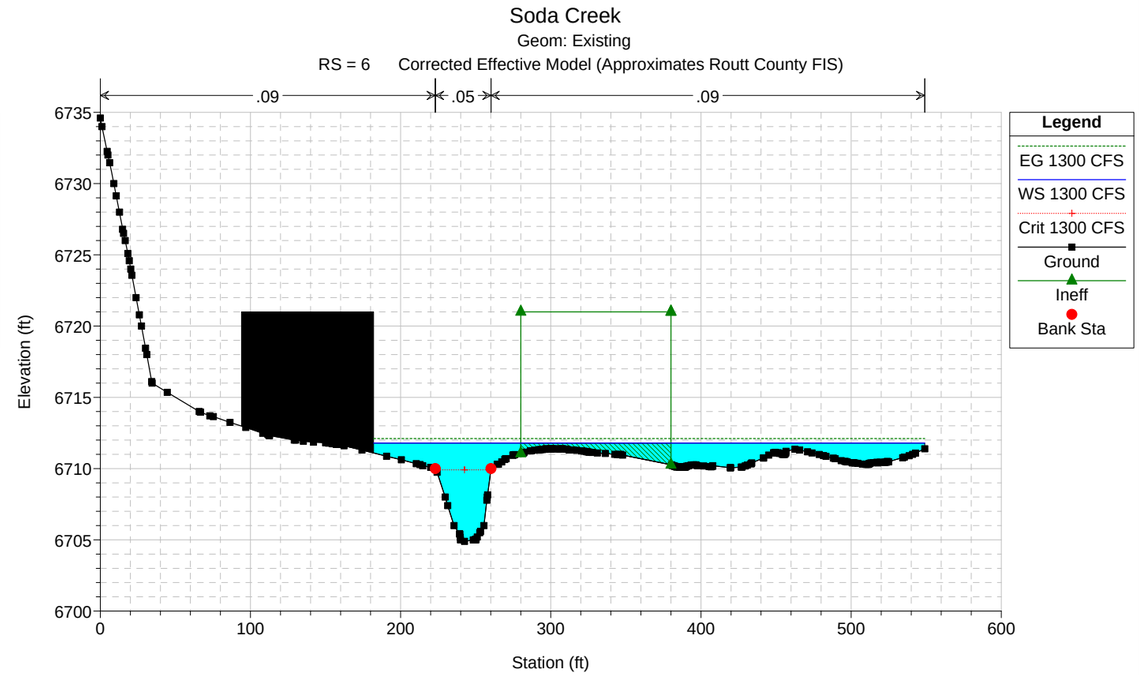

Soda Creek
Geom: Existing
RS = 4.2 Culv 11th Street Lower - Twin 8'W x 6'H CMP Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

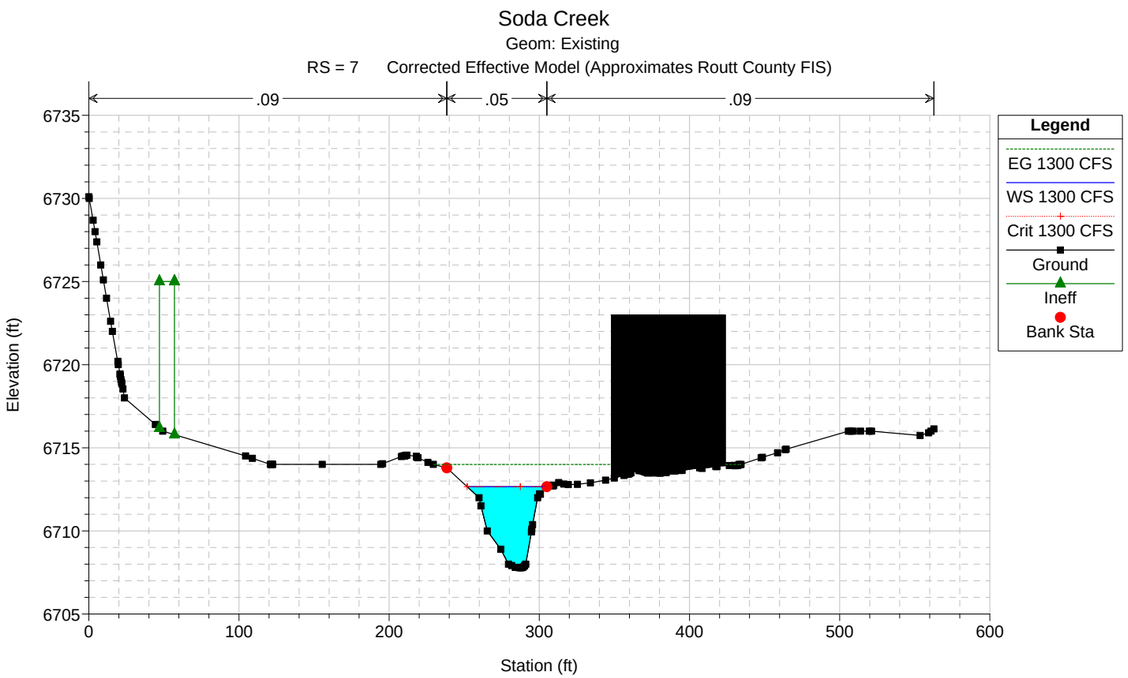

Soda Creek
Geom: Existing
RS = 4.4 Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

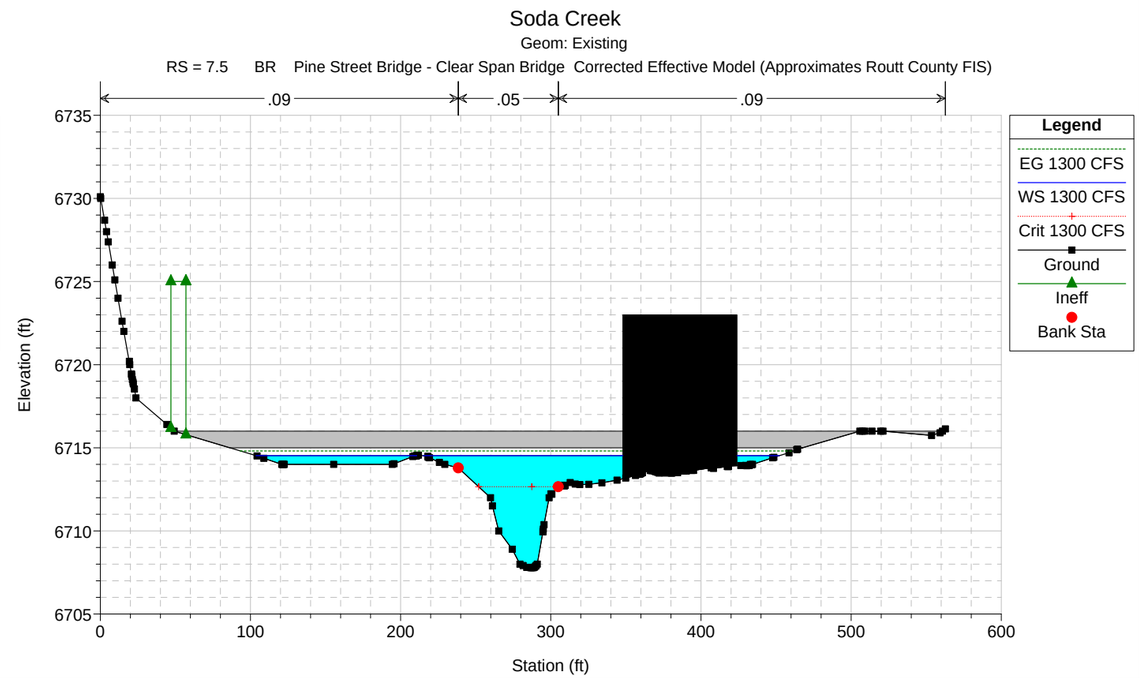

Soda Creek
Geom: Existing
RS = 4.6 Culv 11th Street Upper - Twin 8'W x 6'H CMP Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

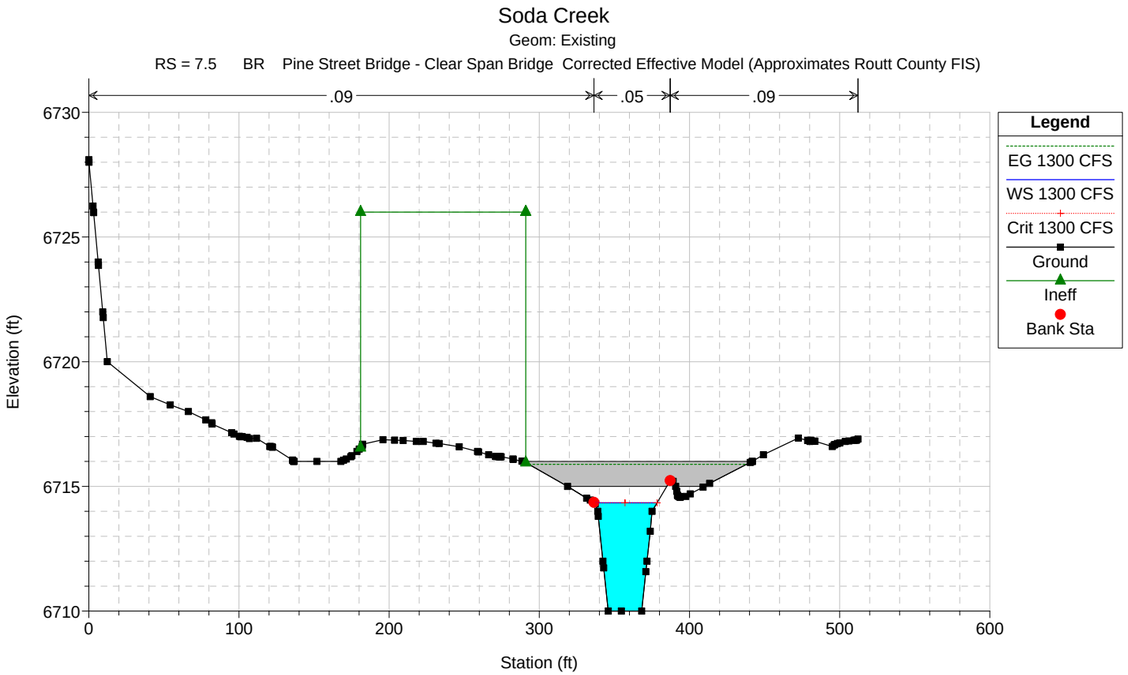

Soda Creek
Geom: Existing
RS = 4.6 Culv 11th Street Upper - Twin 8'W x 6'H CMP Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

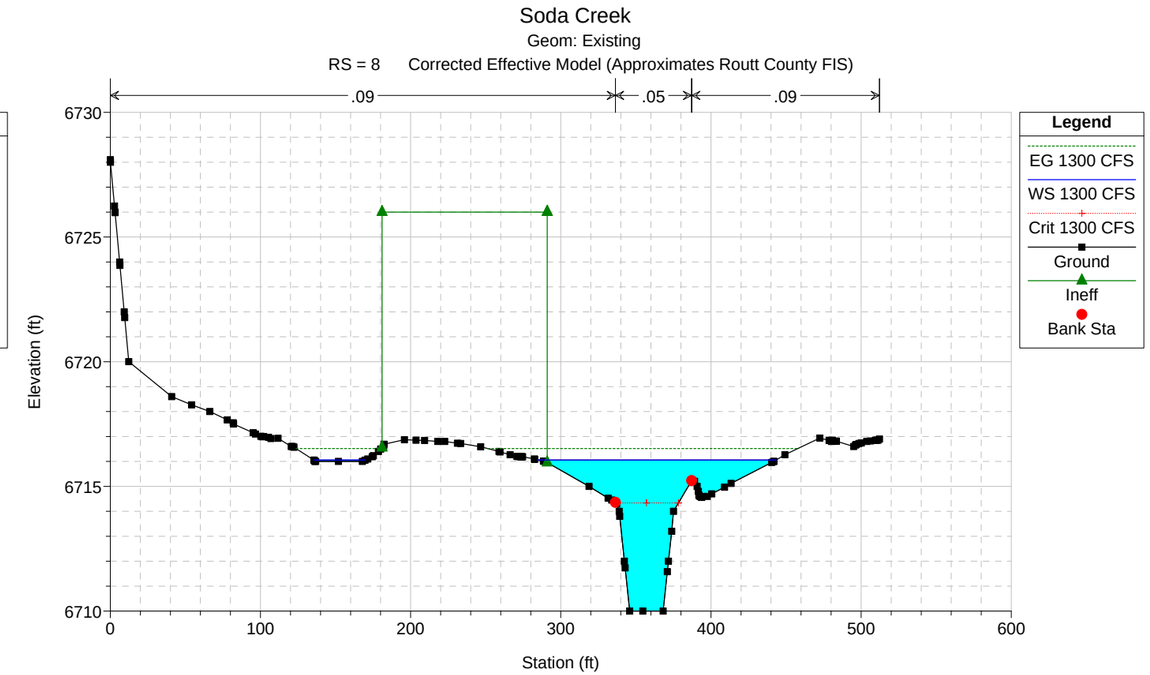

Soda Creek
Geom: Existing
RS = 5 Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

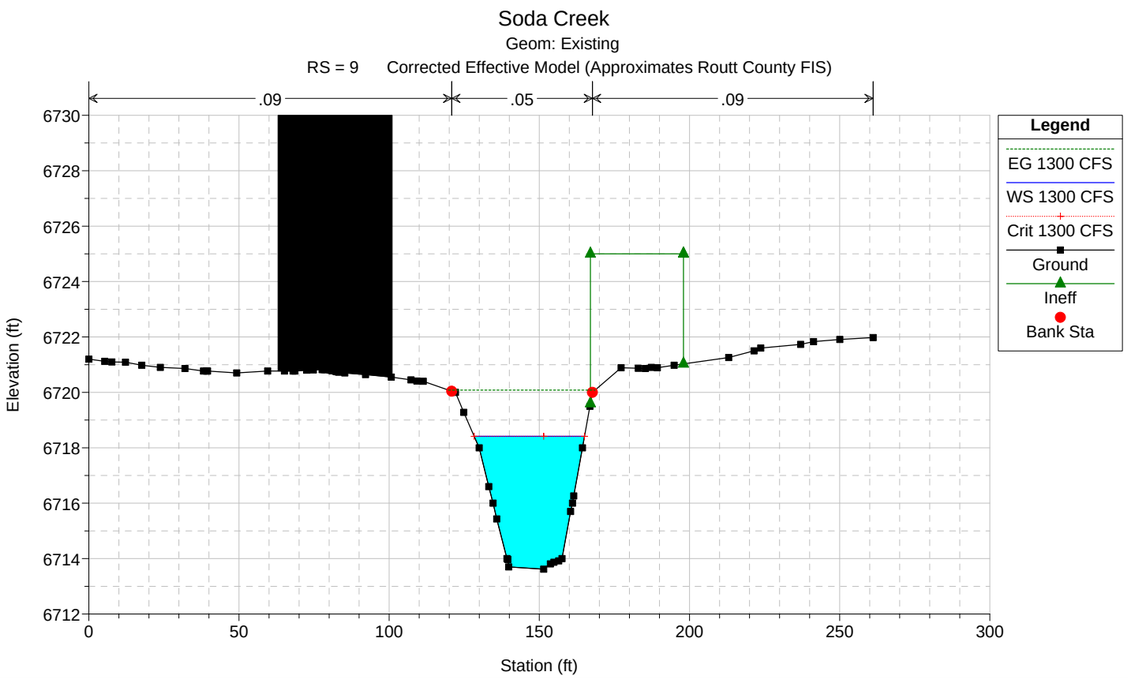

Soda Creek
Geom: Existing
RS = 6 Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

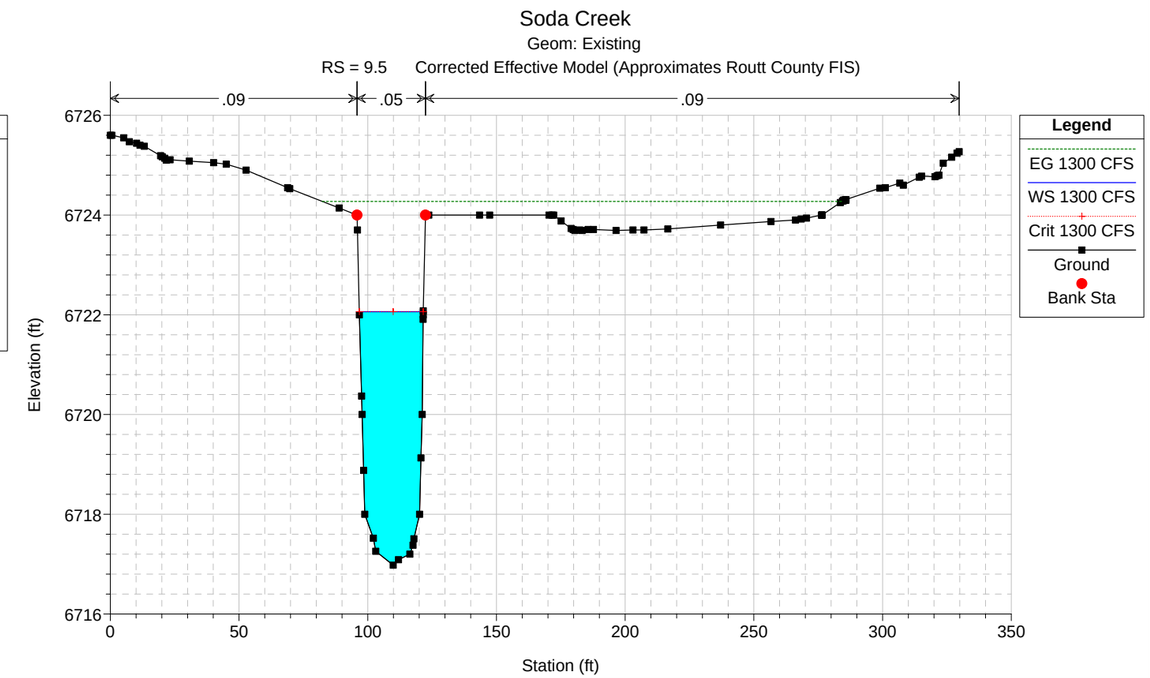

Soda Creek
Geom: Existing
RS = 7 Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

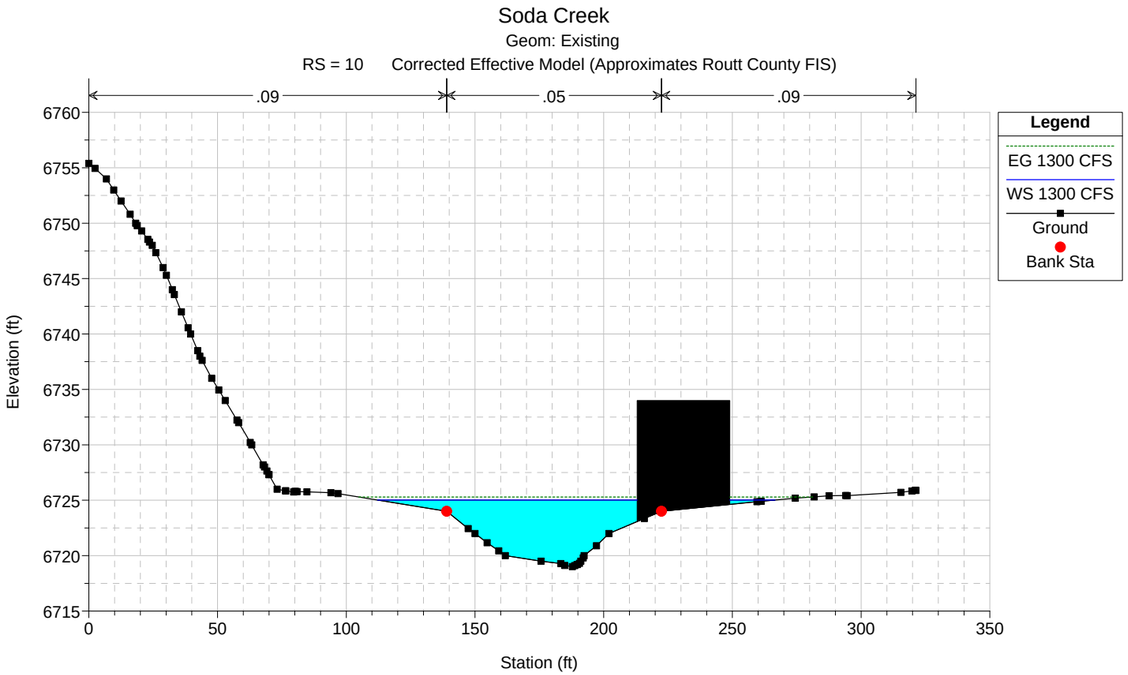

Soda Creek
Geom: Existing
RS = 7.5 BR Pine Street Bridge - Clear Span Bridge Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

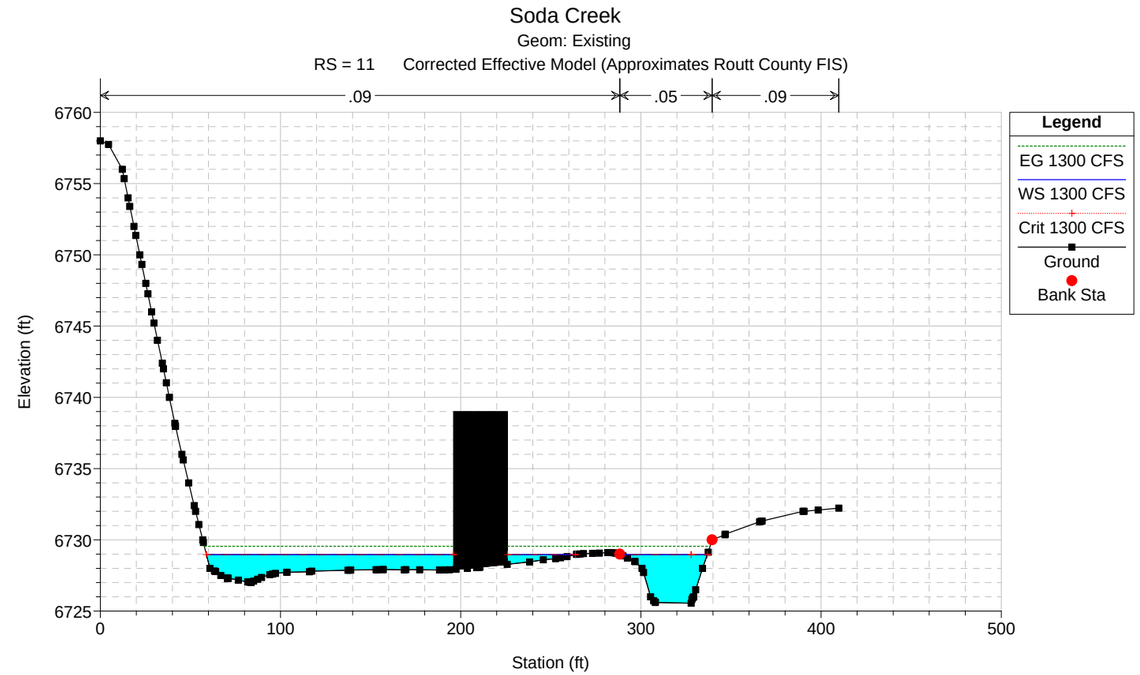

Soda Creek
Geom: Existing
RS = 7.5 BR Pine Street Bridge - Clear Span Bridge Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

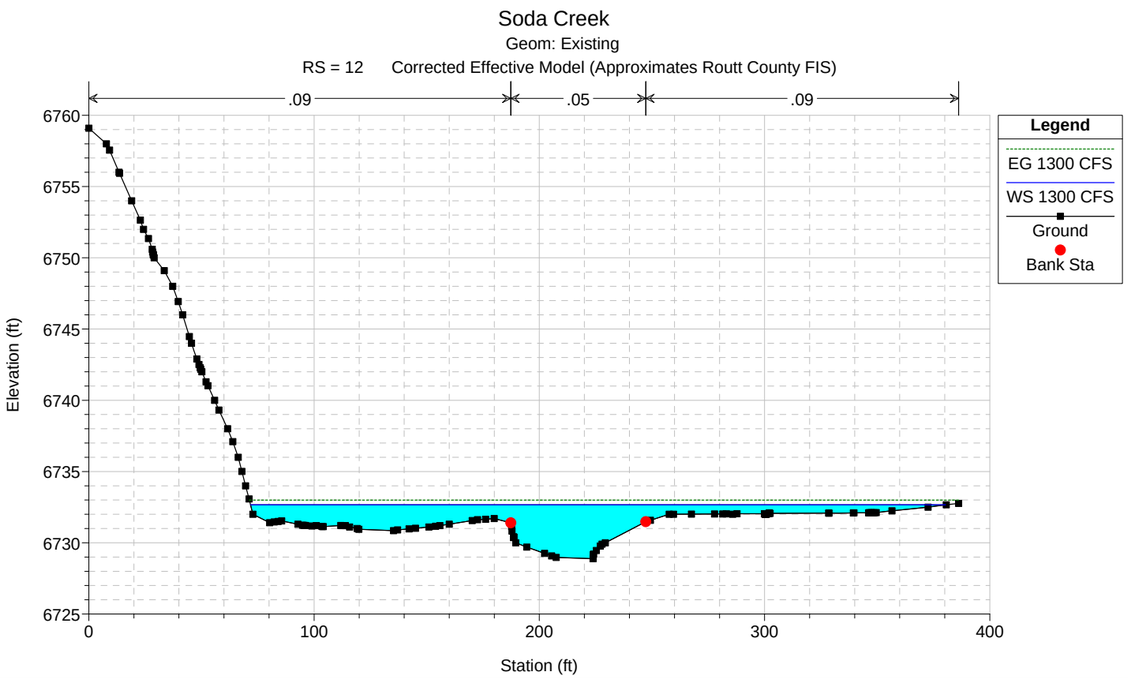

Soda Creek
Geom: Existing
RS = 8 Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

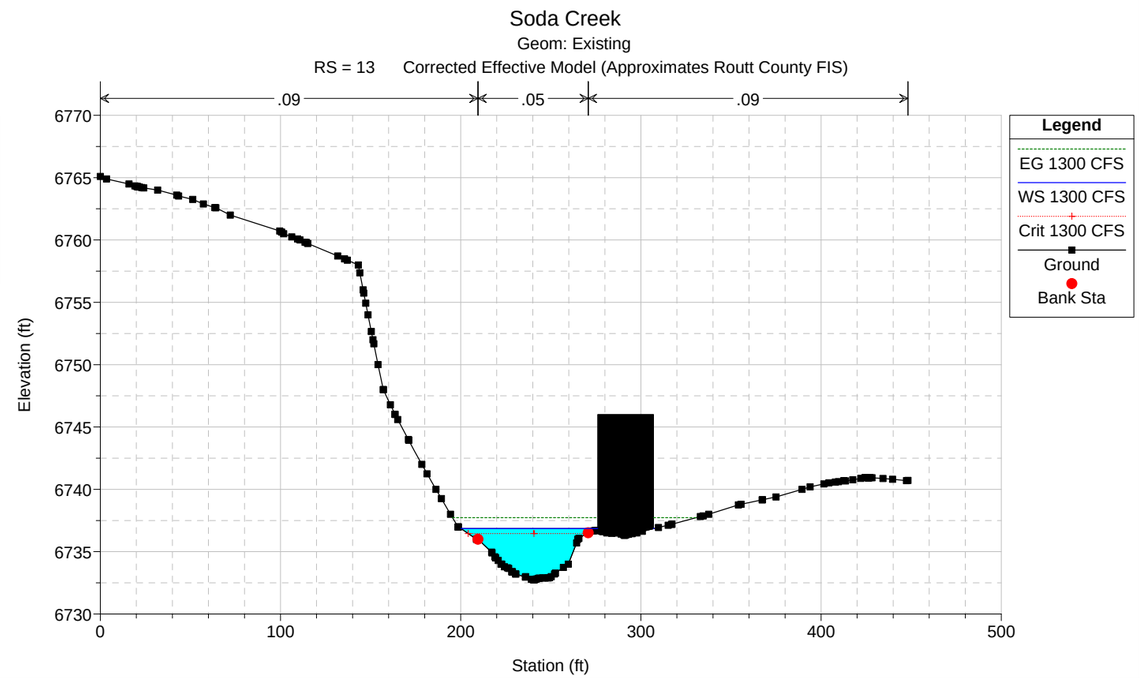

Soda Creek
Geom: Existing
RS = 9 Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

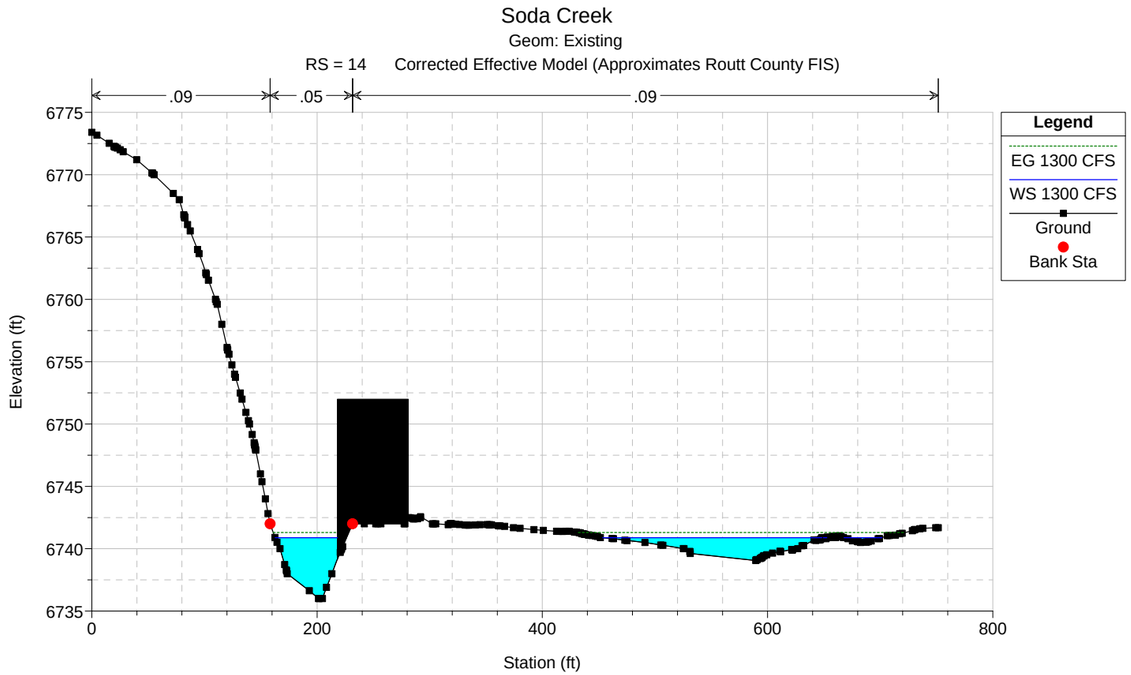

Soda Creek
Geom: Existing
RS = 9.5 Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)

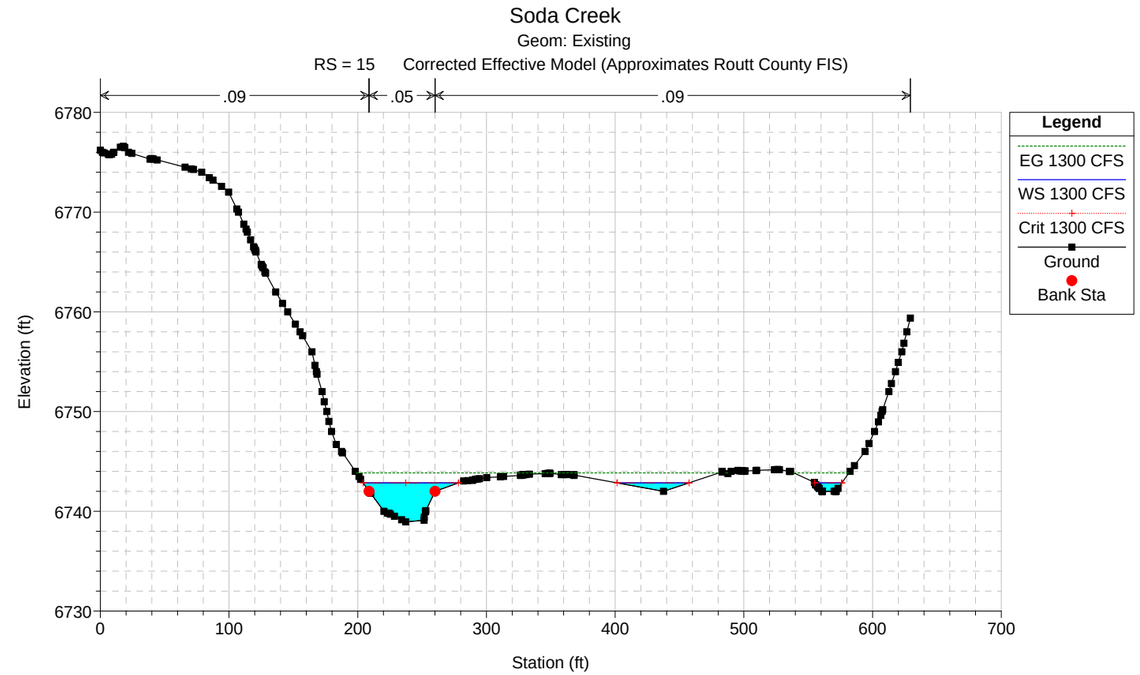

Soda Creek
Geom: Existing
RS = 10 Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)

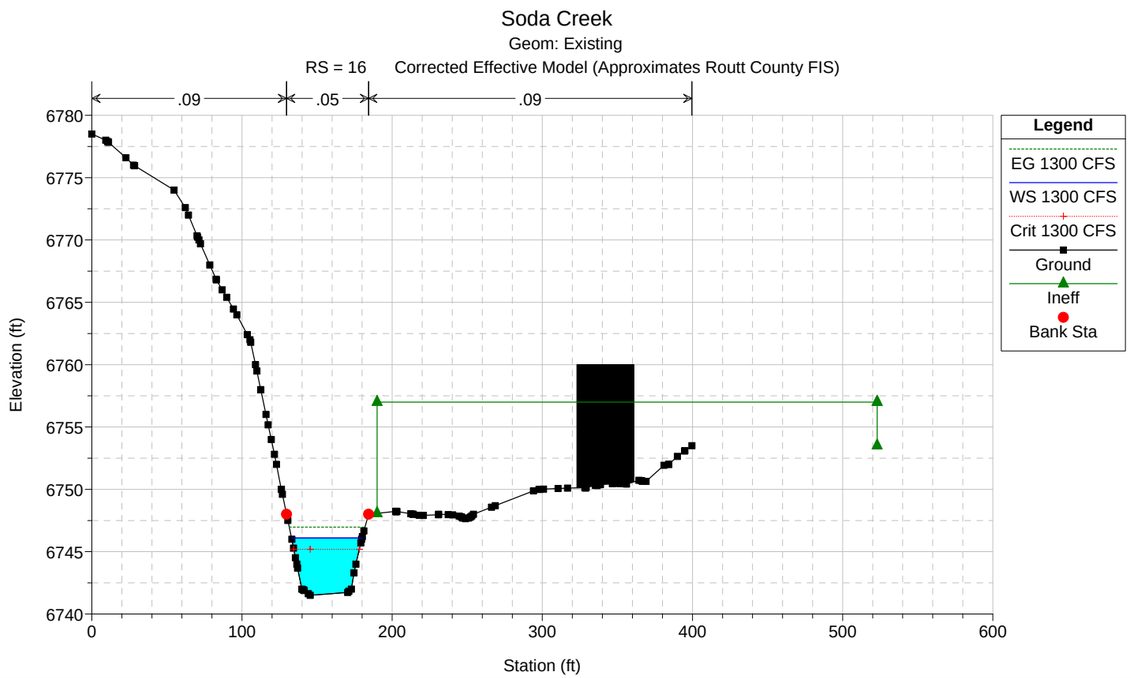

Soda Creek
Geom: Existing
RS = 11 Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)

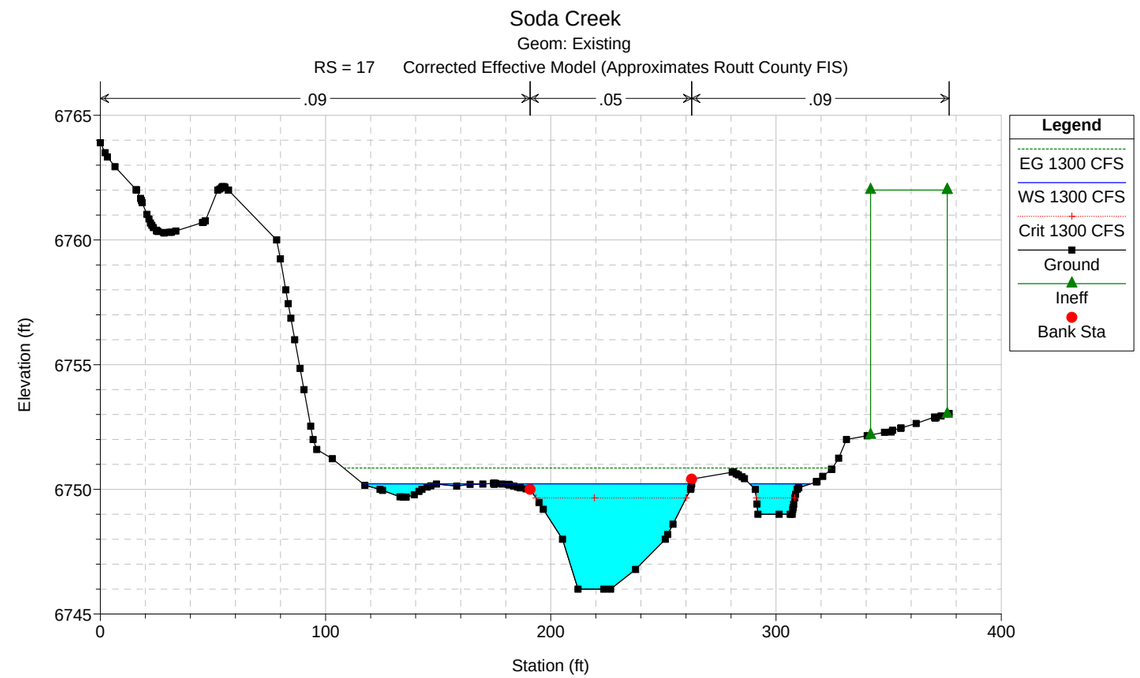

Soda Creek
Geom: Existing
RS = 12 Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)

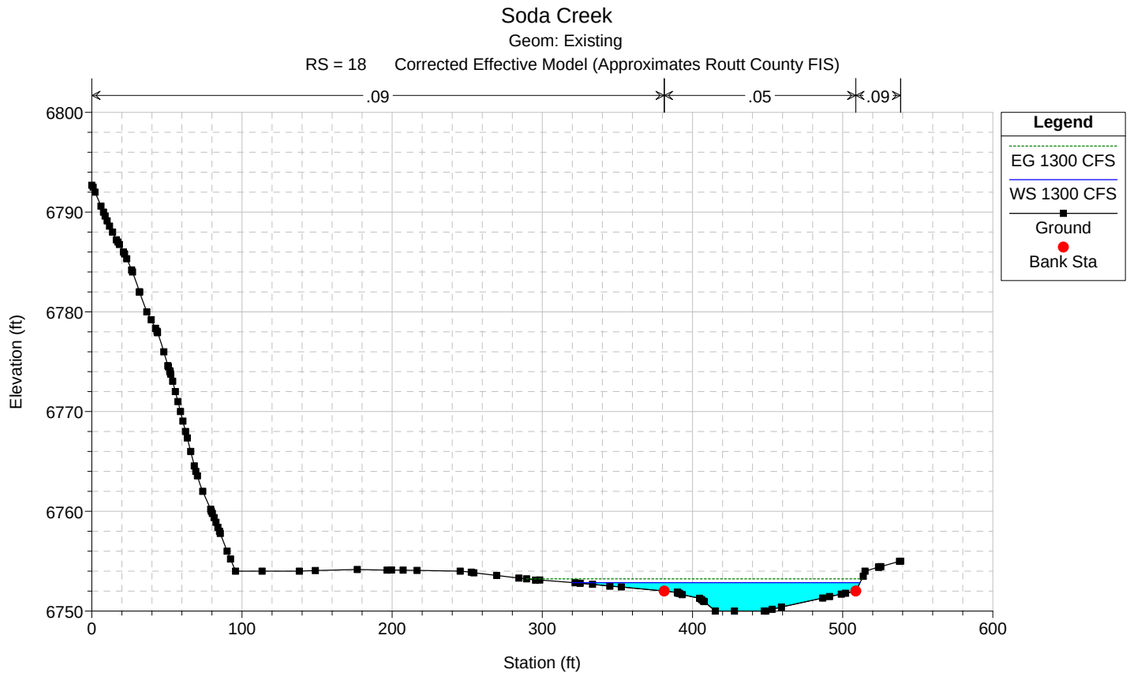

Soda Creek
Geom: Existing
RS = 13 Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)

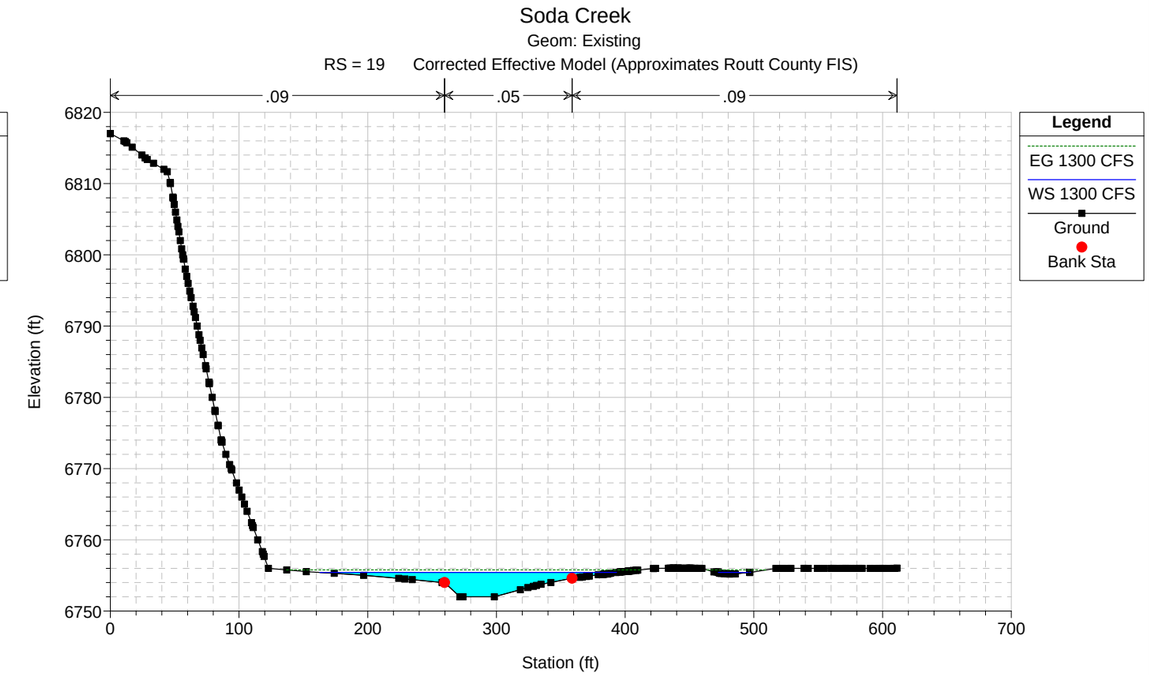

Soda Creek
Geom: Existing
RS = 14 Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)

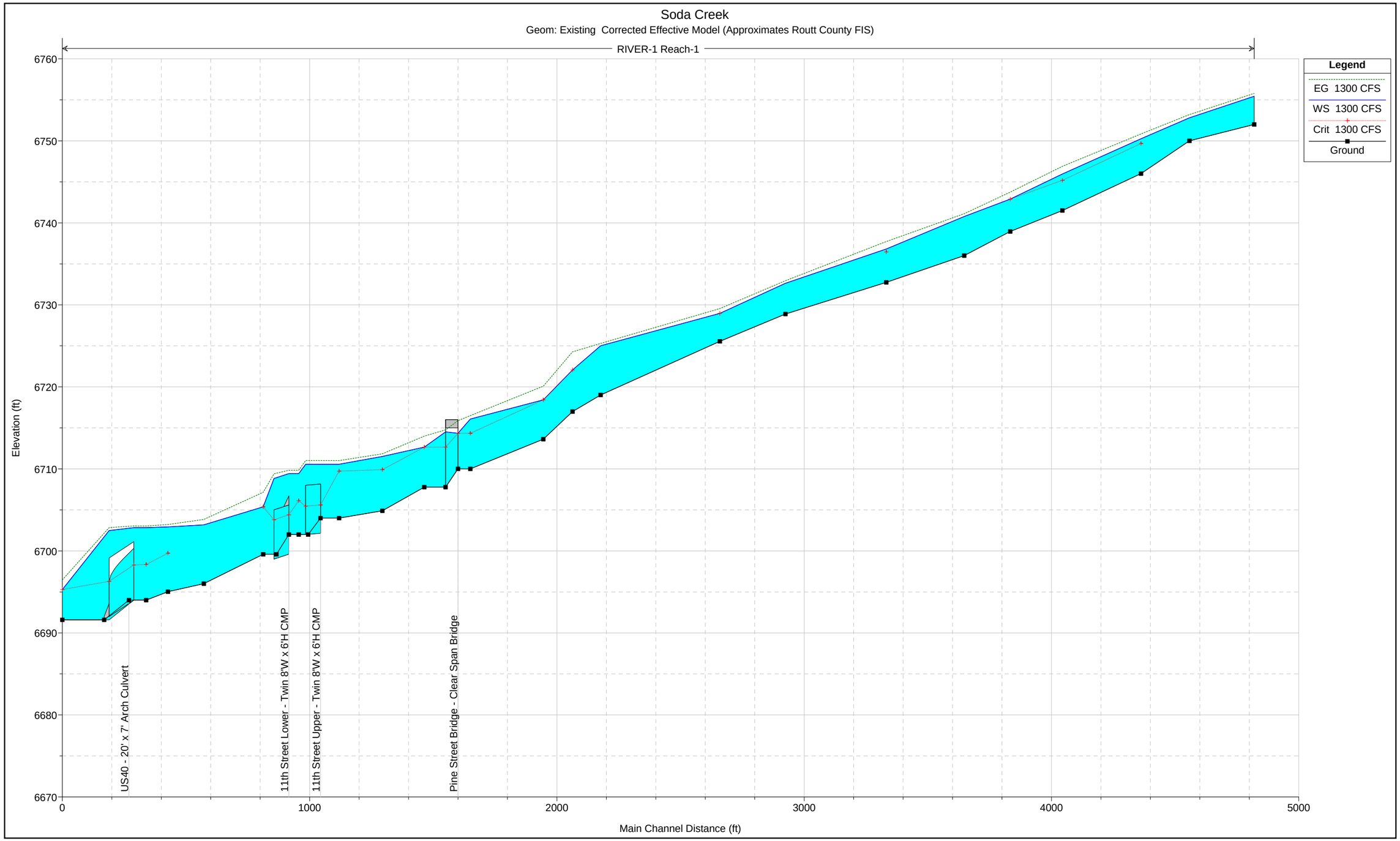

Soda Creek
Geom: Existing
RS = 15 Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)


Soda Creek
Geom: Existing
RS = 16 Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Soda Creek
Geom: Existing
RS = 17 Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Soda Creek
Geom: Existing
RS = 18 Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)

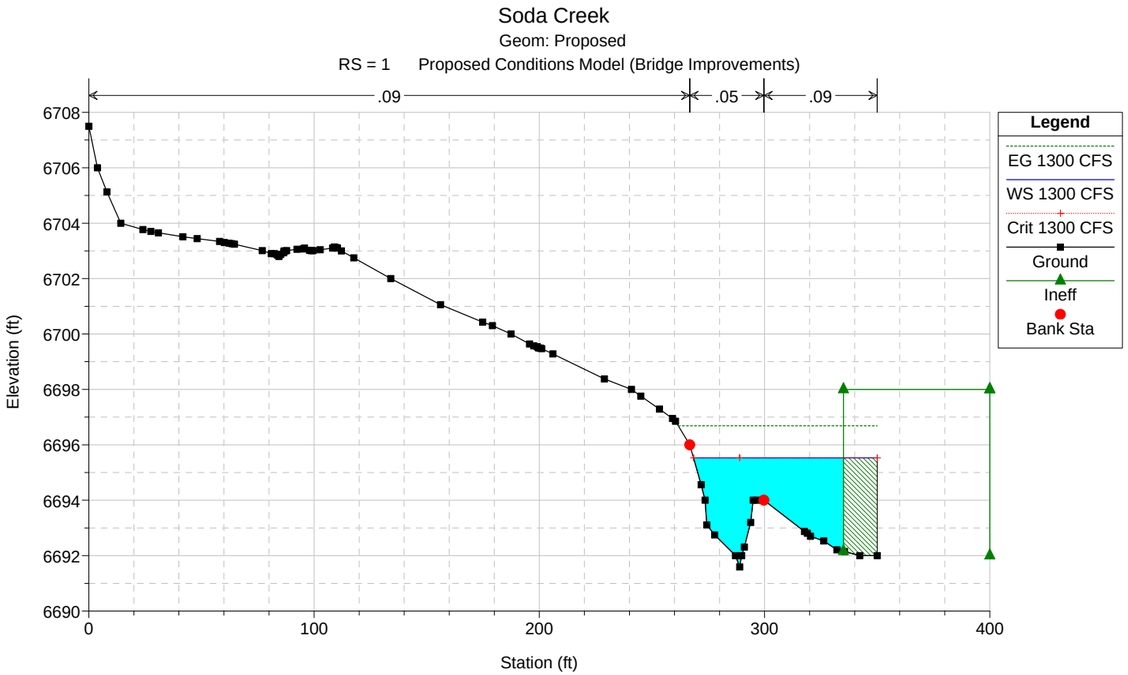

Soda Creek
Geom: Existing
RS = 19 Corrected Effective Model (Approximates Routt County FIS)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)

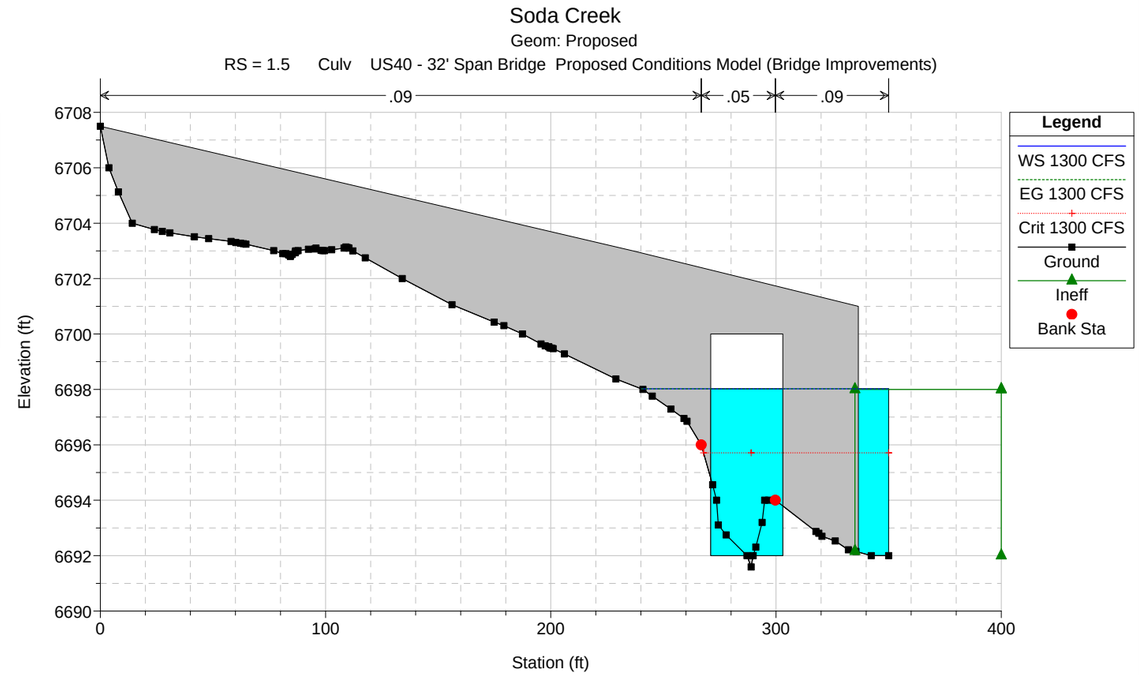

Soda Creek
Geom: Existing Corrected Effective Model (Approximates Routt County FIS)
RIVER-1 Reach-1
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Elevation (ft)
6760
6750
6740
6730
6720
6710
6700
6690
6680
6670
0
1000
2000
3000
4000
5000
Main Channel Distance (ft)
US40 - 20' x 7' Arch Culvert
11th Street Lower - Twin 8'W x 6'H CMP
11th Street Upper - Twin 8'W x 6'H CMP
Pine Street Bridge - Clear Span Bridge

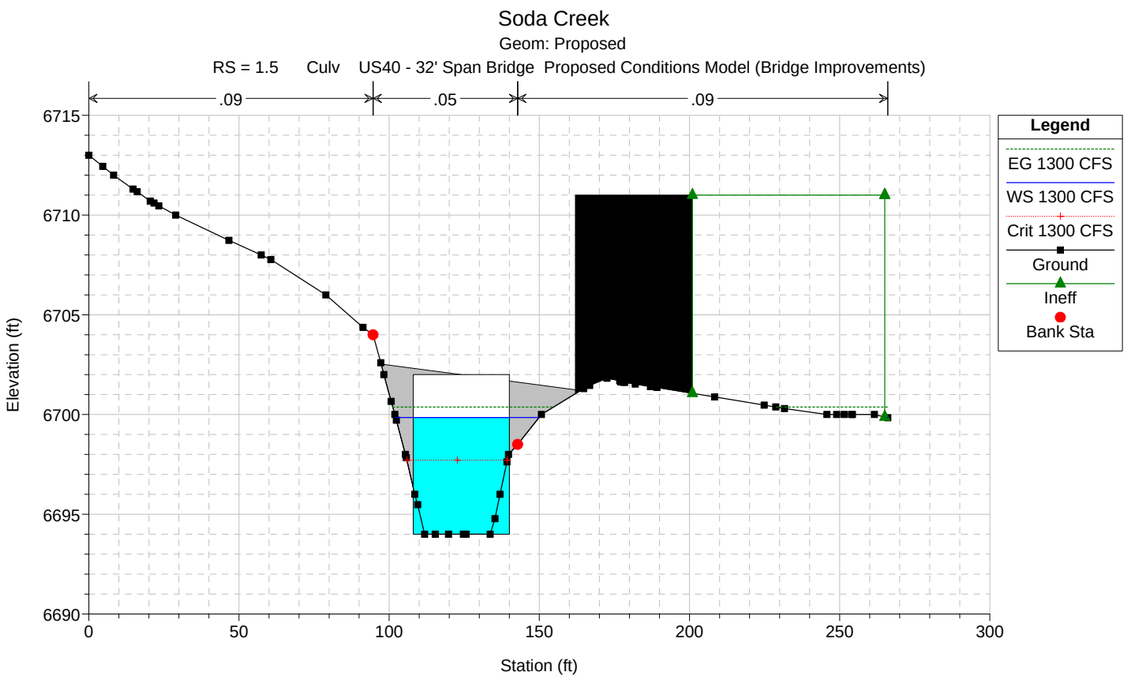
HEC-RAS OUTPUT FOR SODA CREEK – PROPOSED CONDITIONS MODEL

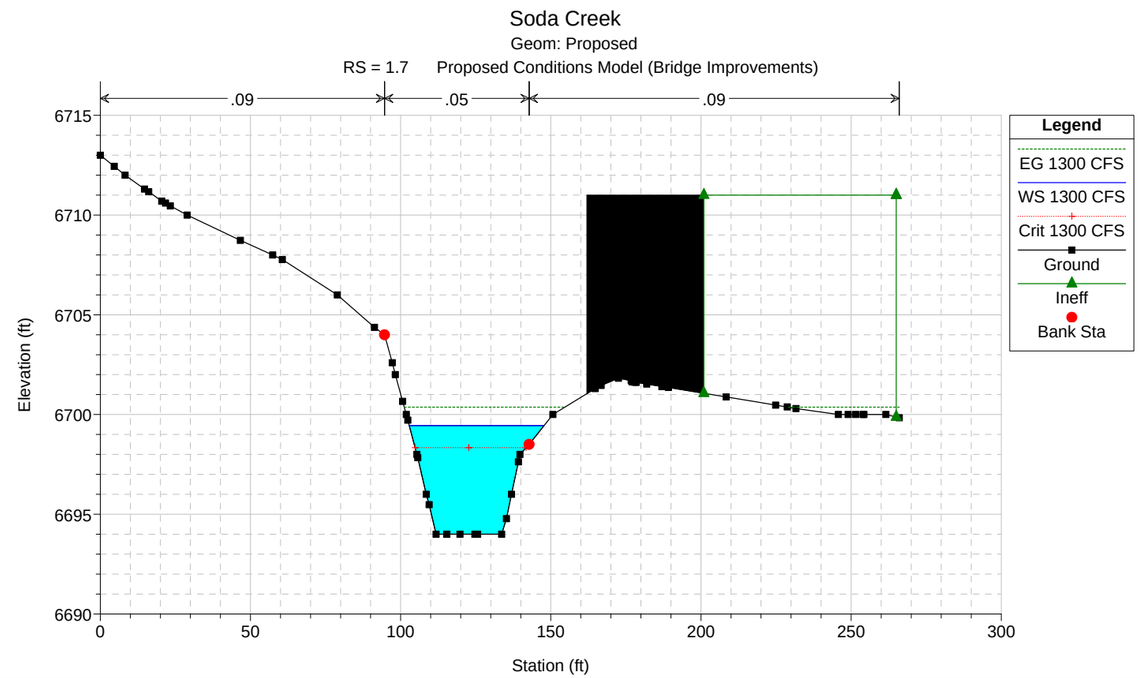
Soda Creek - Proposed Conditions Model (Culvert / Bridge Improvements)

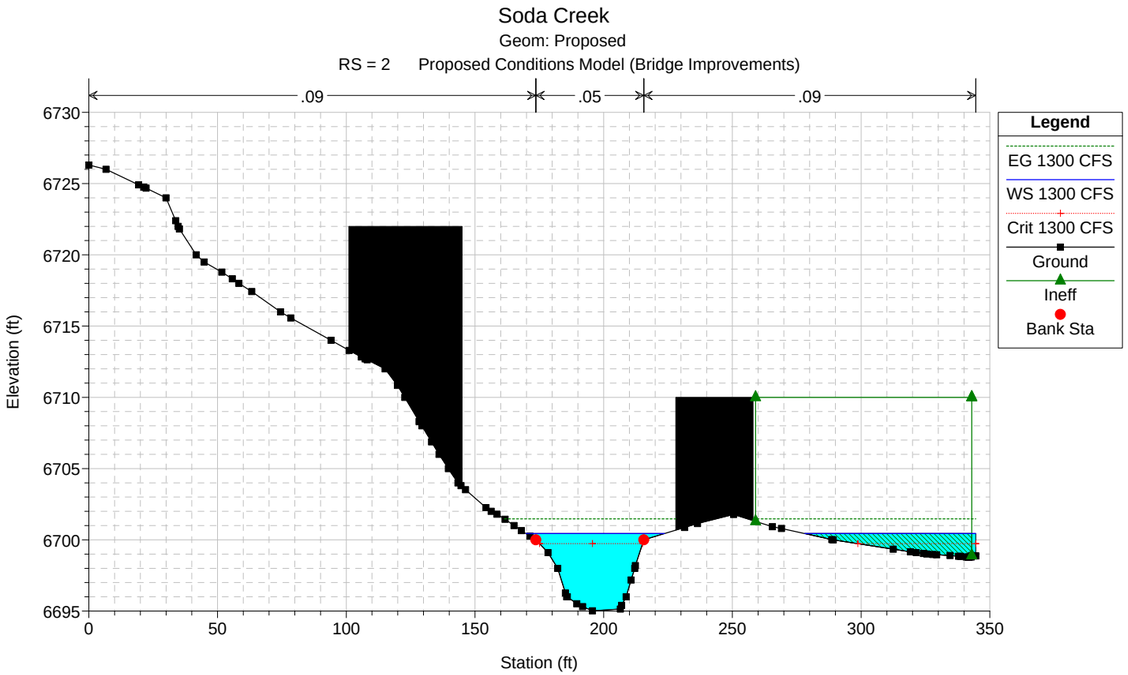
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach-1	19	1300 CFS	1300	6752	6755.42		6755.78	0.00864	5.01	323.5	254.5	0.56
Reach-1	18	1300 CFS	1300	6750	6752.85		6753.23	0.01120	4.99	282.0	191.6	0.62
Reach-1	17	1300 CFS	1300	6746	6750.22	6749.66	6750.85	0.01280	6.49	227.1	167.2	0.69
Reach-1	16	1300 CFS	1300	6741.5	6746.1	6745.19	6746.97	0.01170	7.47	174.1	46.9	0.68
Reach-1	15	1300 CFS	1300	6738.94	6742.85	6742.85	6743.85	0.01863	8.21	197.5	151.2	0.85
Reach-1	14	1300 CFS	1300	6736	6740.88		6741.30	0.00809	5.74	368.8	286.5	0.56
Reach-1	13	1300 CFS	1300	6732.74	6736.86	6736.46	6737.73	0.01649	7.53	177.3	76.2	0.79
Reach-1	12	1300 CFS	1300	6728.88	6732.66		6732.99	0.00798	5.35	409.0	308.5	0.55
Reach-1	11	1300 CFS	1300	6725.55	6728.96	6728.96	6729.55	0.02360	7.56	288.1	222.8	0.9
Reach-1	10	1300 CFS	1300	6719.01	6725.02		6725.29	0.00322	4.23	322.2	118.4	0.37
Reach-1	9.5	1300 CFS	1300	6716.98	6722.06	6722.06	6724.27	0.02938	11.93	108.9	24.8	1
Reach-1	9	1300 CFS	1300	6713.62	6718.41	6718.41	6720.08	0.02556	10.36	125.5	36.8	0.99
Reach-1	8	1300 CFS	1300	6710	6716.06	6714.34	6716.52	0.00559	5.63	302.3	193.7	0.48
Reach-1	7.5		Bridge									
Reach-1	7	1300 CFS	1300	6707.78	6712.65	6712.65	6713.99	0.02772	9.28	140.1	53.0	1.01
Reach-1	6	1300 CFS	1300	6704.89	6711.84	6709.91	6712.14	0.00336	5.01	483.3	367.0	0.38
Reach-1	5	1300 CFS	1300	6704	6709.73	6709.73	6710.92	0.01812	9.16	184.9	207.1	0.83
Reach-1	4.6		Culvert									
Reach-1	4.4	1300 CFS	1300	6702	6706.12	6706.12	6707.83	0.02572	10.52	123.6	44.2	1
Reach-1	4.2		Culvert									
Reach-1	4	1300 CFS	1300	6699.59	6705.67	6705.26	6707.26	0.01679	10.28	146.2	49.1	0.81
Reach-1	3	1300 CFS	1300	6696	6702.32	6701.27	6703.50	0.01376	8.74	156.3	56.8	0.72
Reach-1	2	1300 CFS	1300	6695.02	6700.44	6699.73	6701.47	0.01366	8.16	163.6	120.2	0.74
Reach-1	1.7	1300 CFS	1300	6694	6699.45	6698.34	6700.37	0.01085	7.72	170.5	44.9	0.66
Reach-1	1.5		Culvert									
Reach-1	1	1300 CFS	1300	6691.59	6695.53	6695.53	6696.69	0.03795	10.12	165.2	81.5	1.15

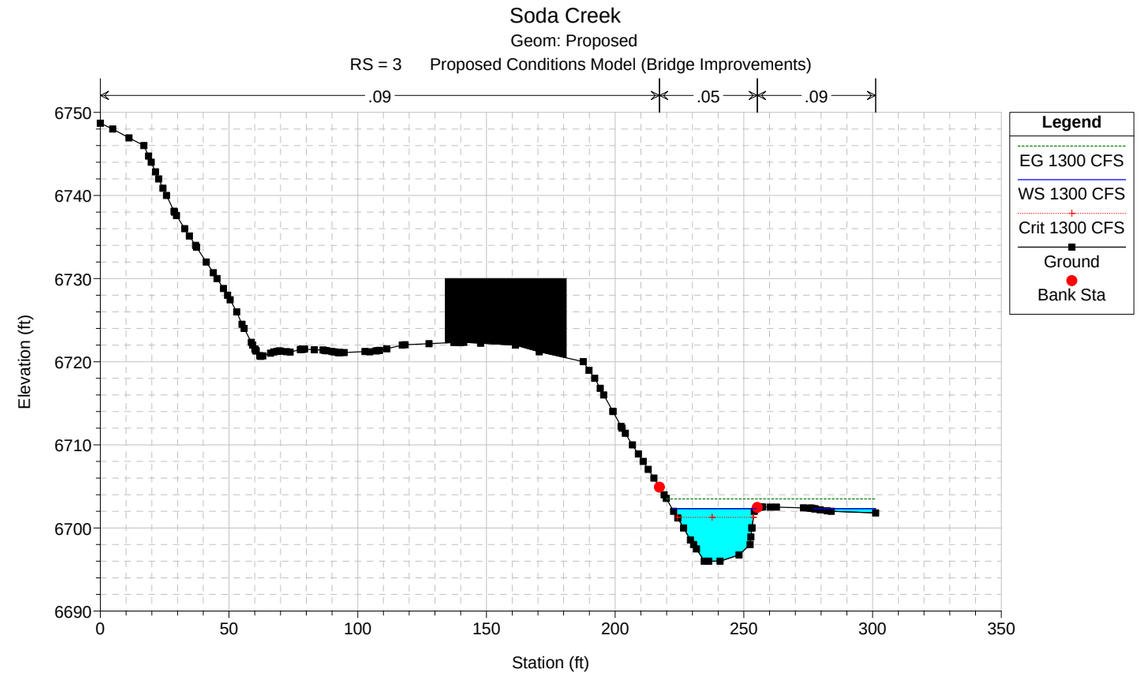

Soda Creek
Geom: Proposed
RS = 1 Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

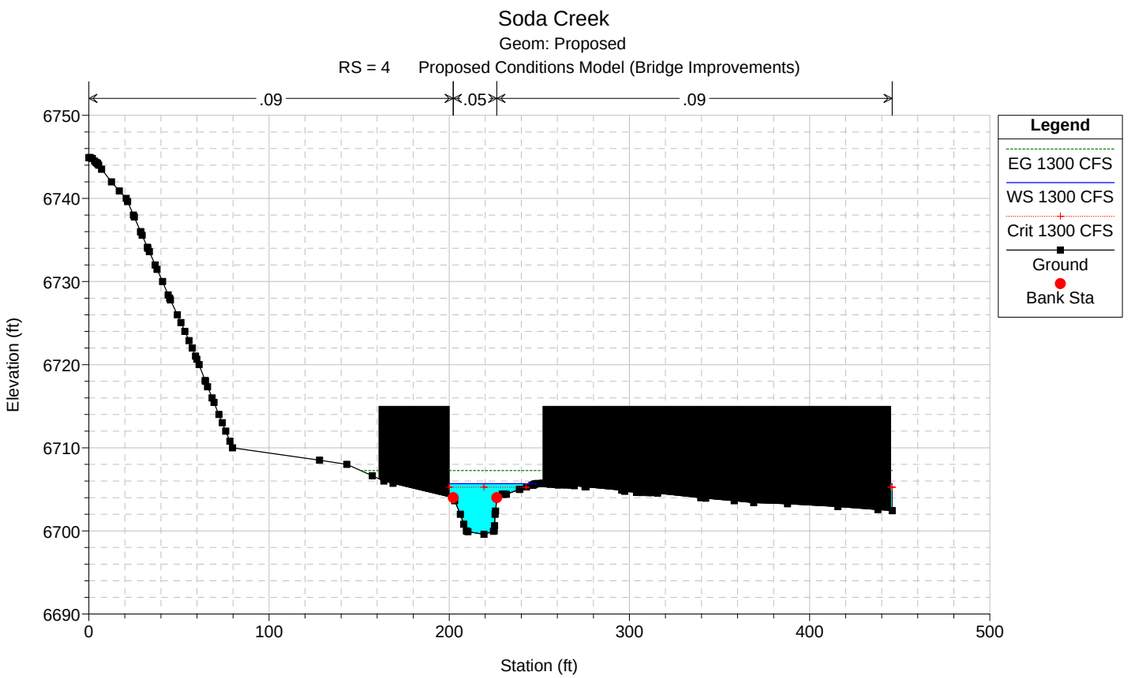

Soda Creek
Geom: Proposed
RS = 1.5 Culv US40 - 32' Span Bridge Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
WS 1300 CFS
EG 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

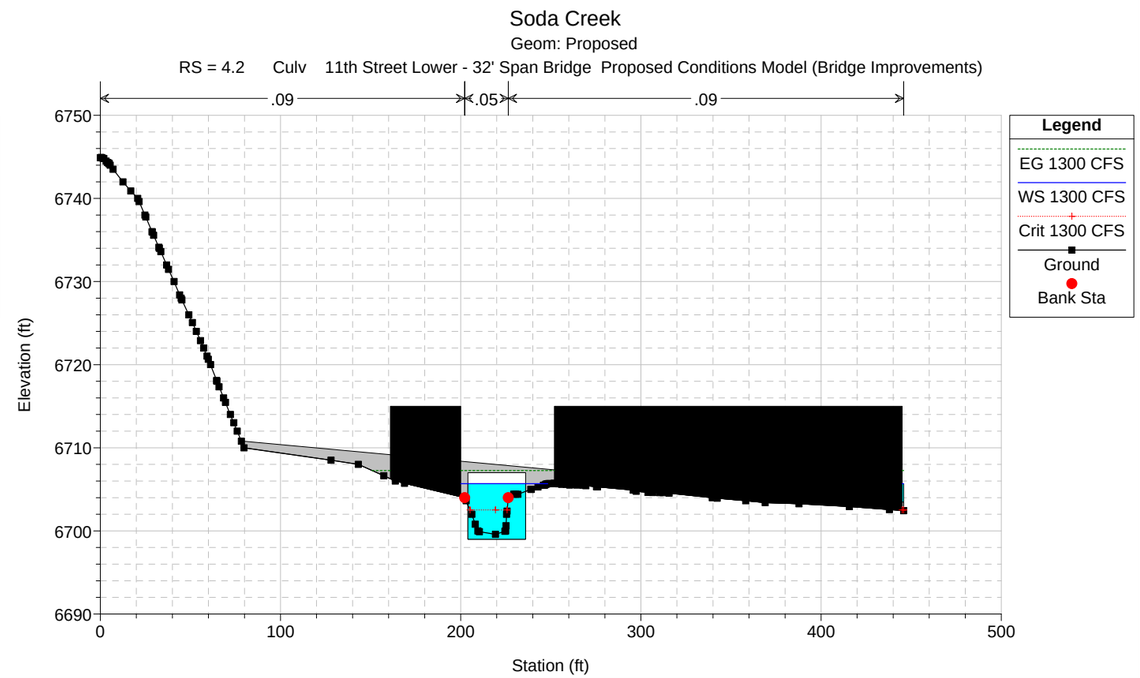

Soda Creek
Geom: Proposed
RS = 1.5 Culv US40 - 32' Span Bridge Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

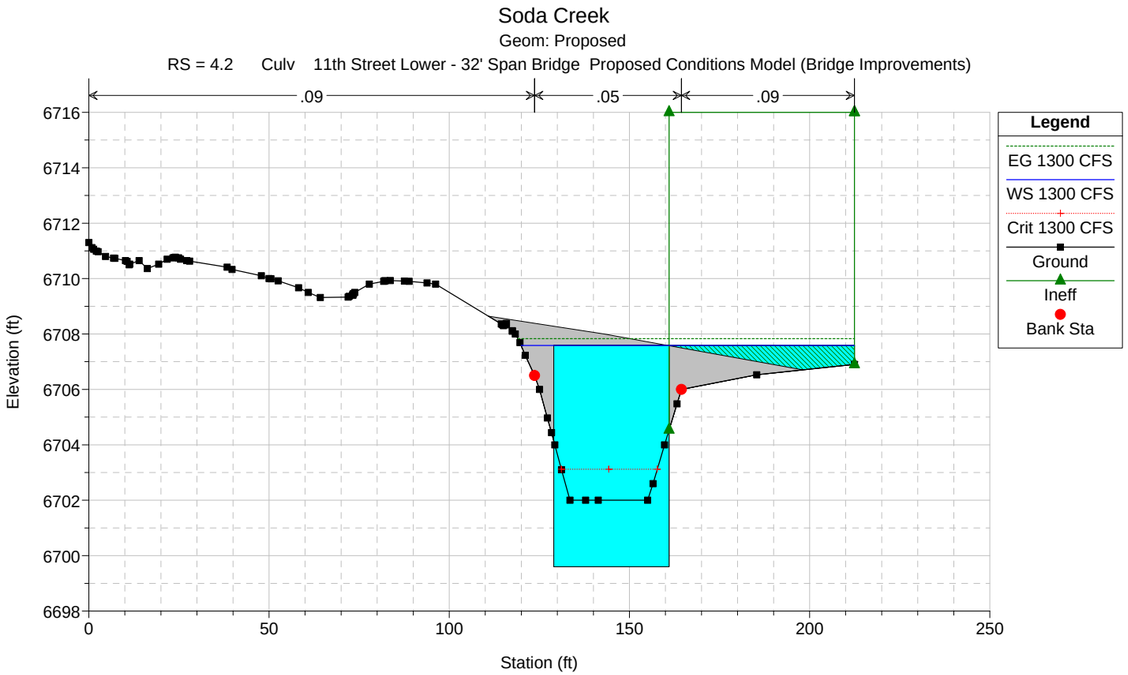

Soda Creek
Geom: Proposed
RS = 1.7 Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

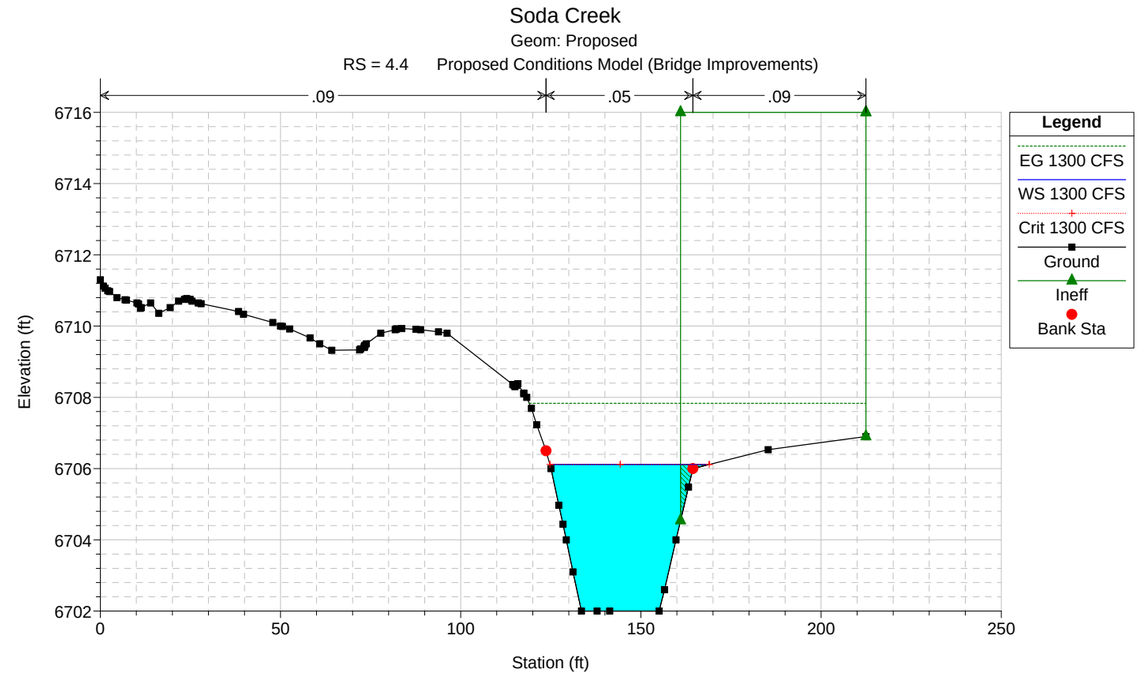

Soda Creek
Geom: Proposed
RS = 2 Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

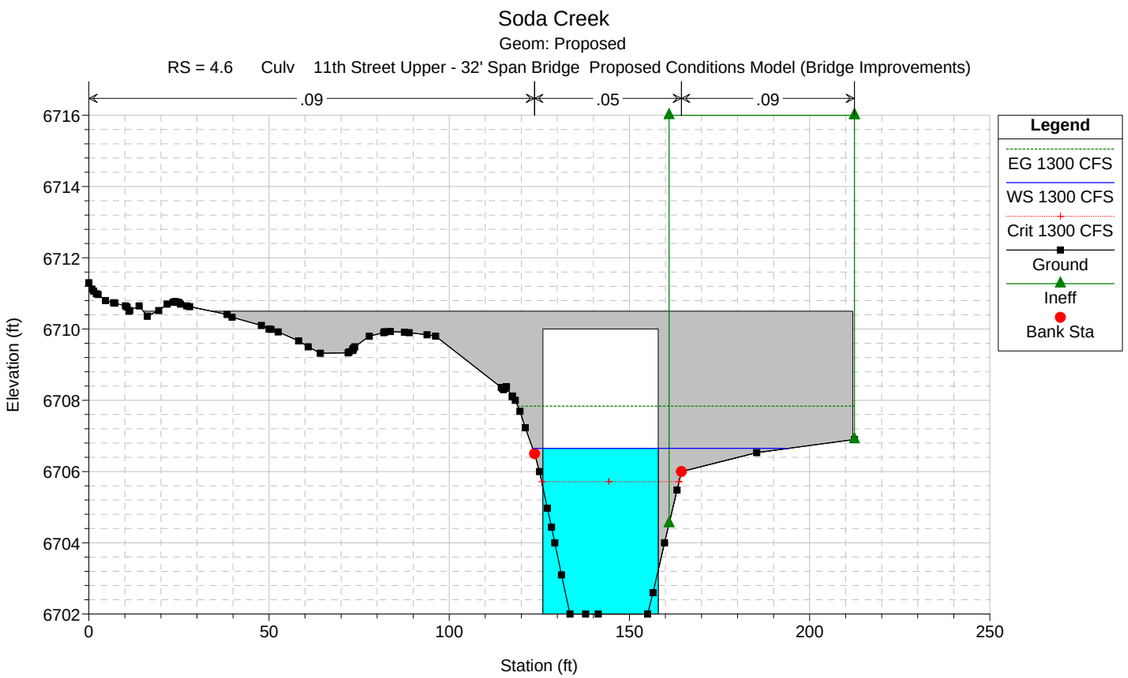

Soda Creek
Geom: Proposed
RS = 3 Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)

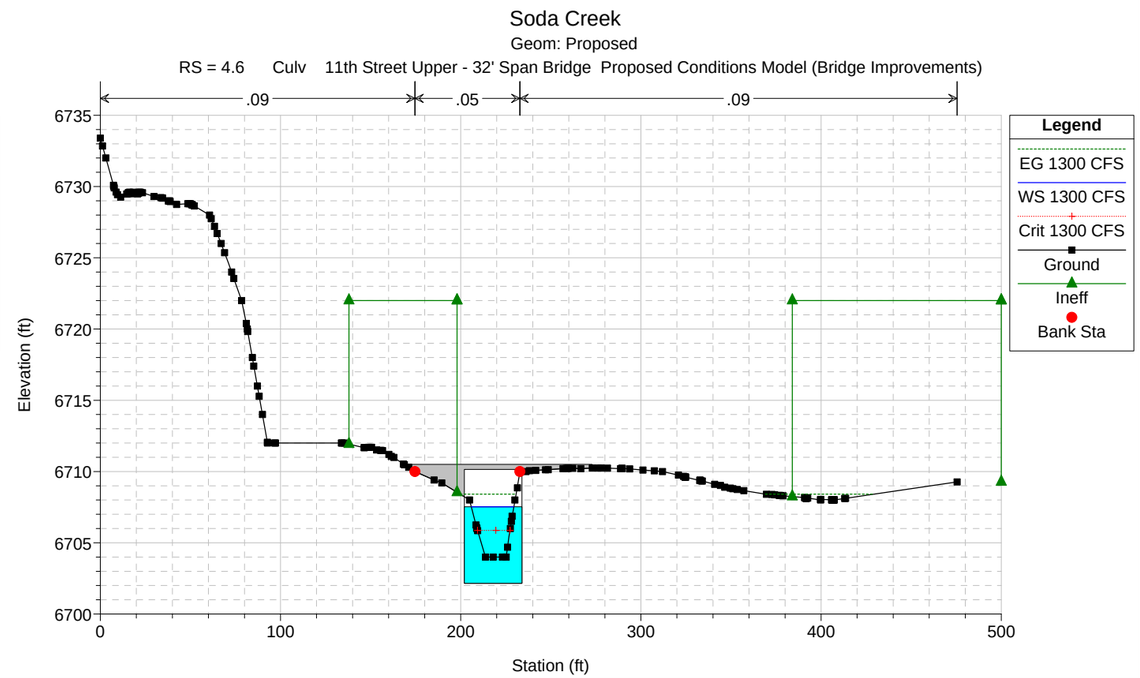

Soda Creek
Geom: Proposed
RS = 4 Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)

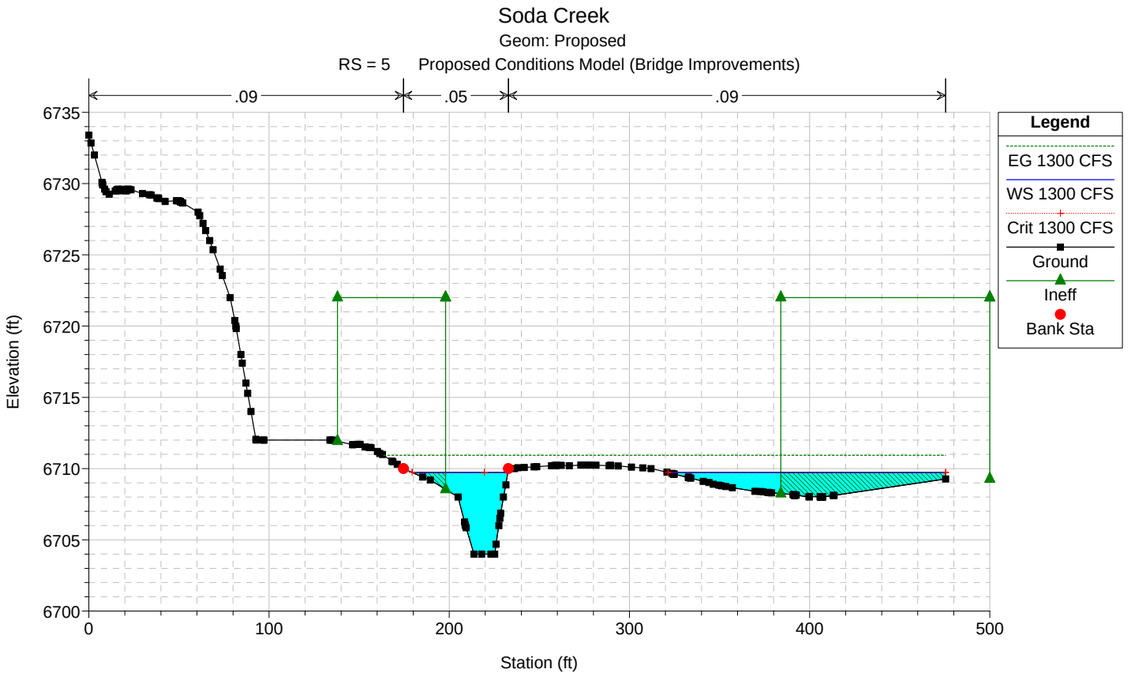

Soda Creek
Geom: Proposed
RS = 4.2 Culv 11th Street Lower - 32' Span Bridge Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)

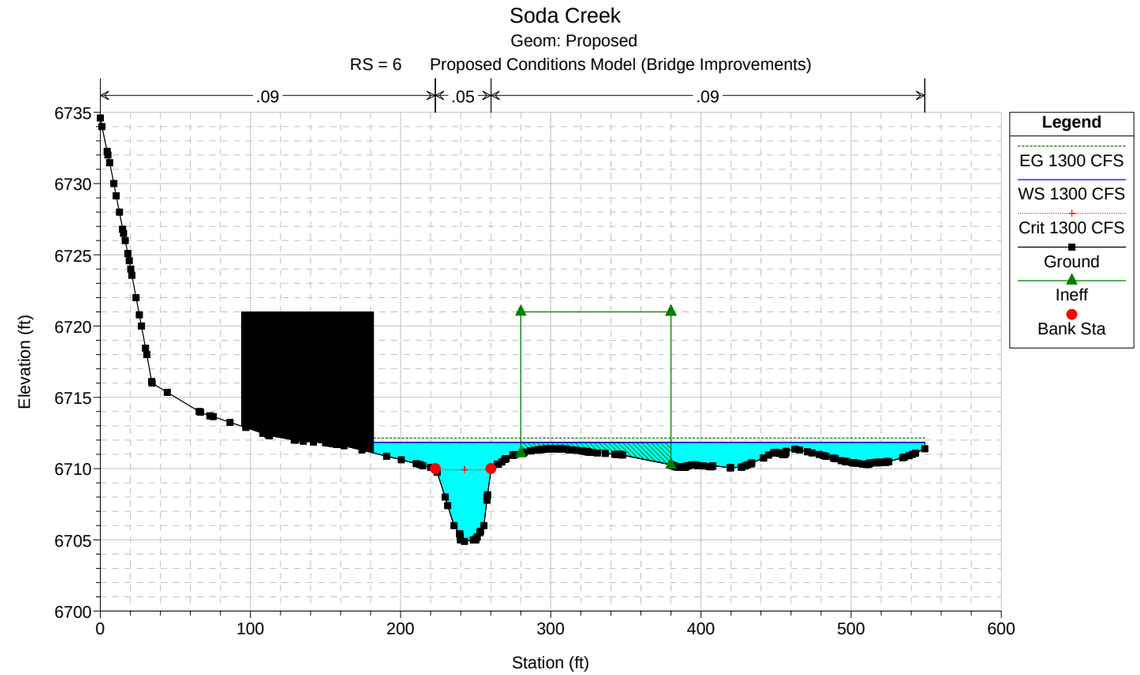

Soda Creek
Geom: Proposed
RS = 4.2 Culv 11th Street Lower - 32' Span Bridge Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

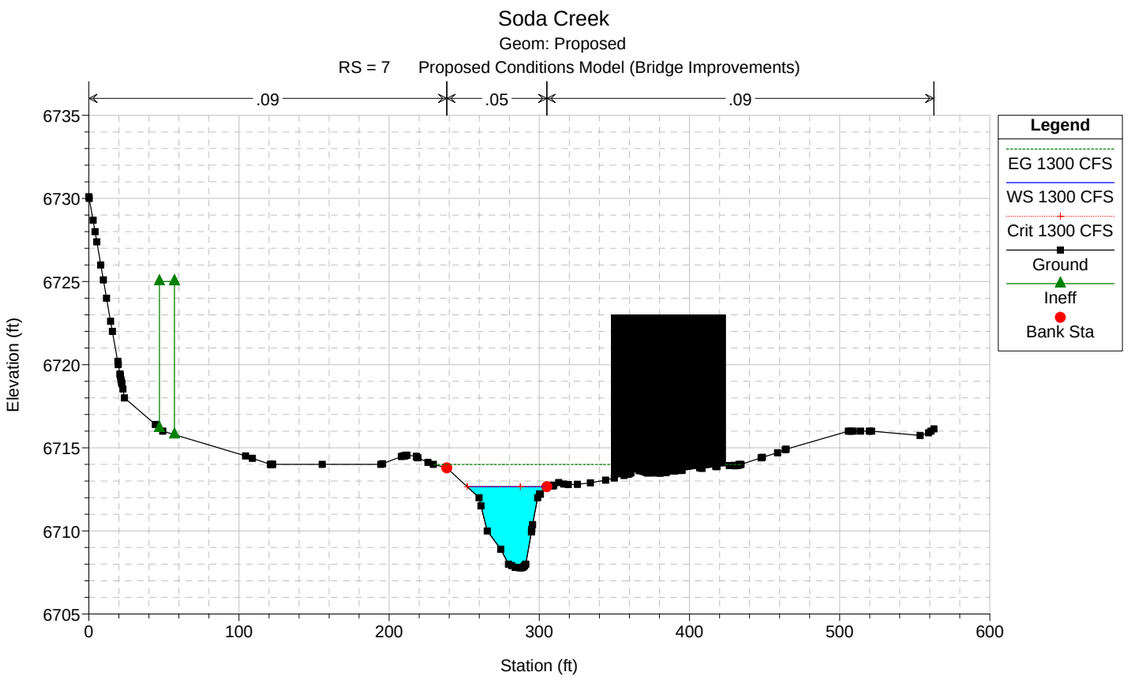

Soda Creek
Geom: Proposed
RS = 4.4 Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

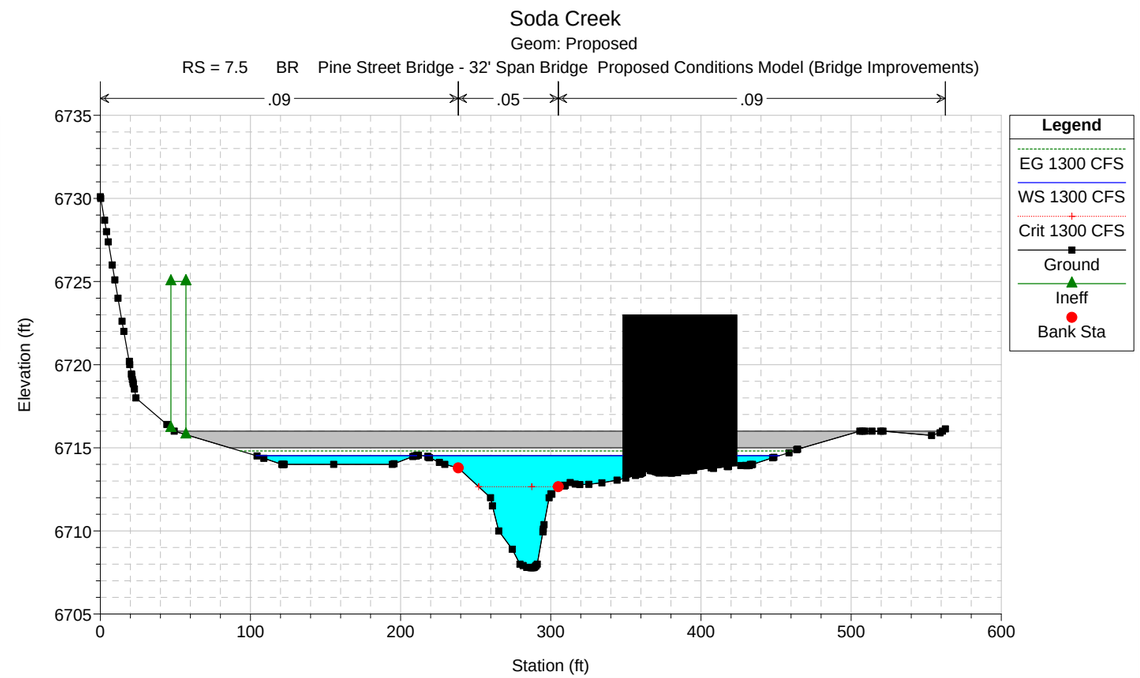

Soda Creek
Geom: Proposed
RS = 4.6 Culv 11th Street Upper - 32' Span Bridge Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

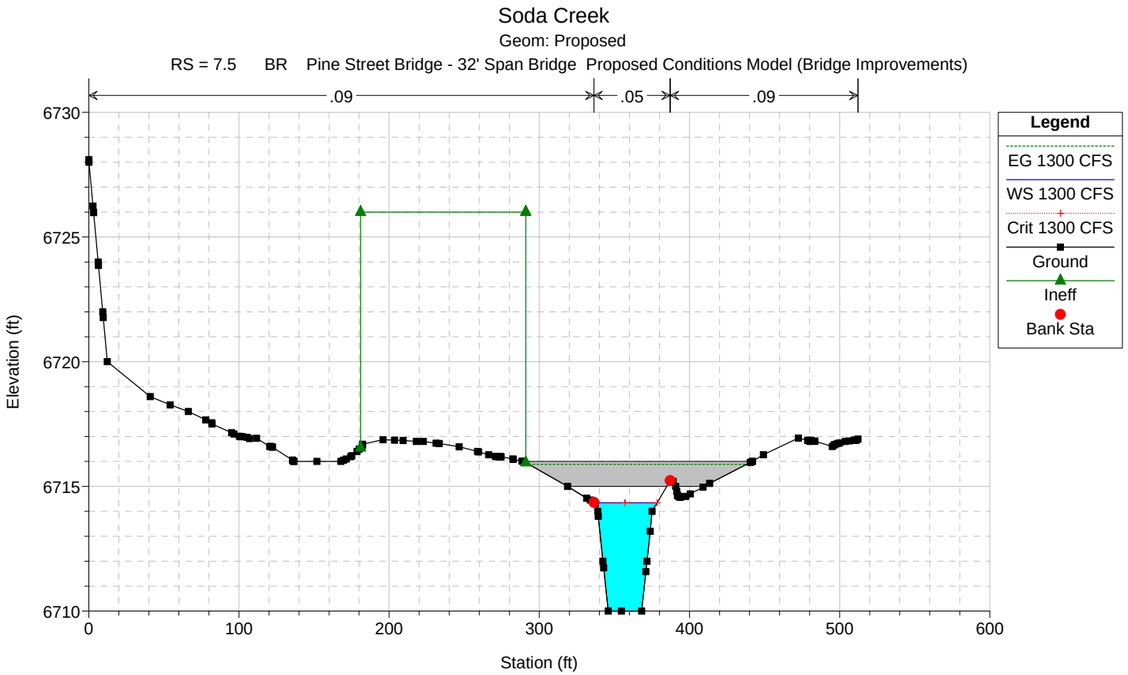

Soda Creek
Geom: Proposed
RS = 4.6 Culv 11th Street Upper - 32' Span Bridge Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

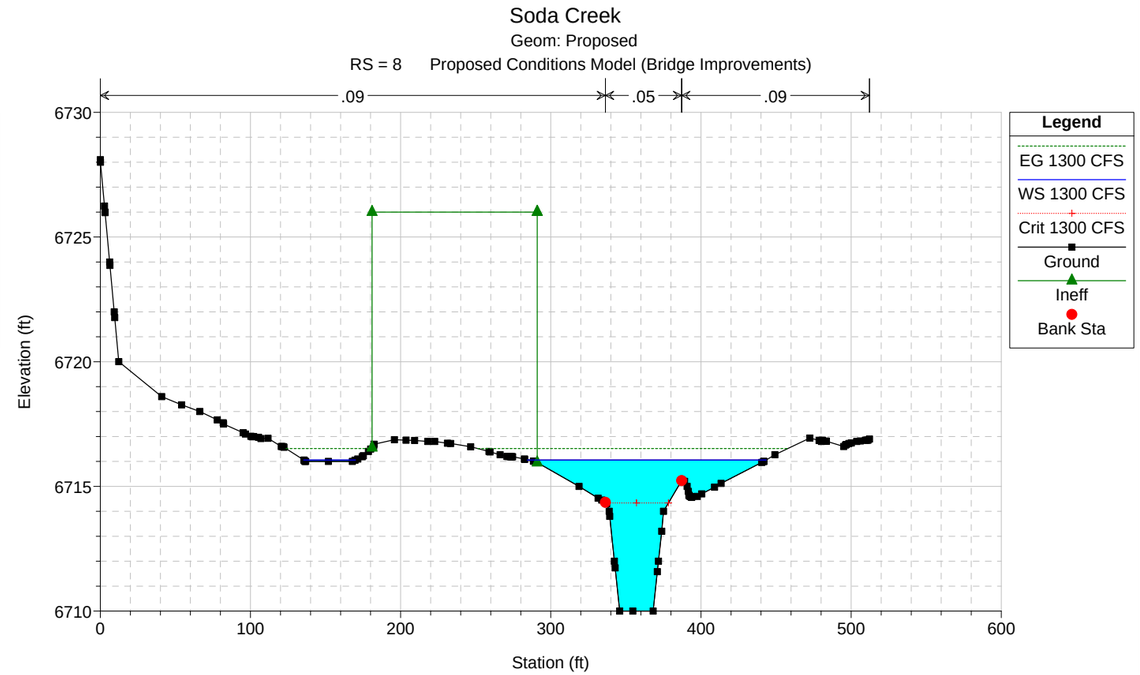

Soda Creek
Geom: Proposed
RS = 5 Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

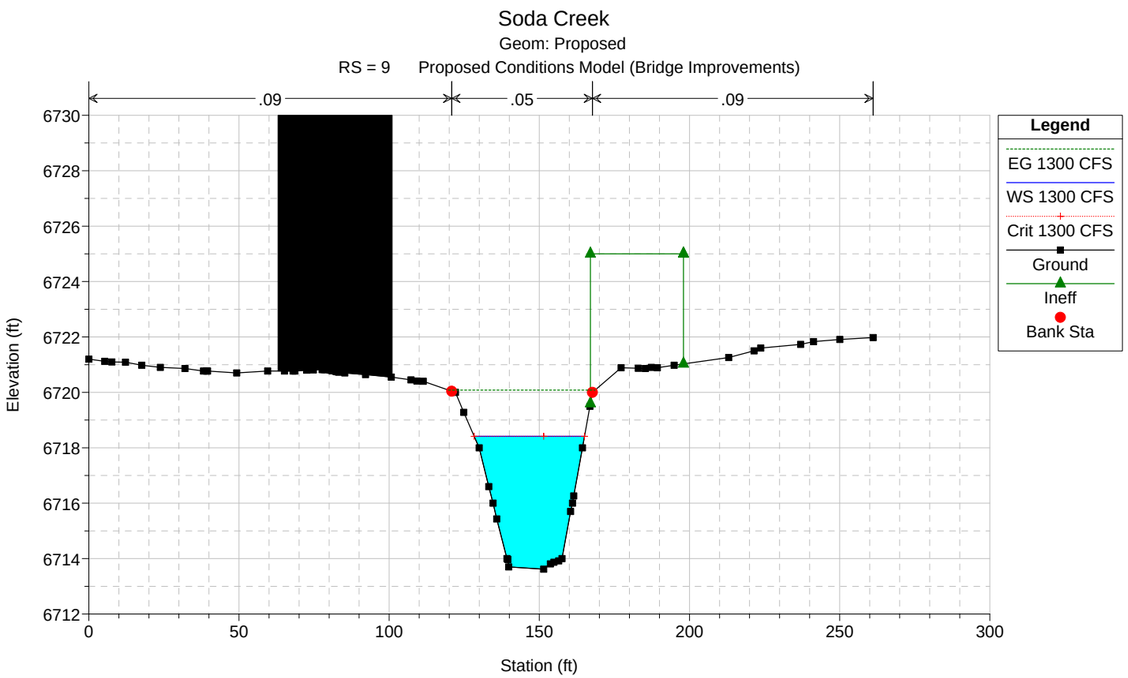

Soda Creek
Geom: Proposed
RS = 6 Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

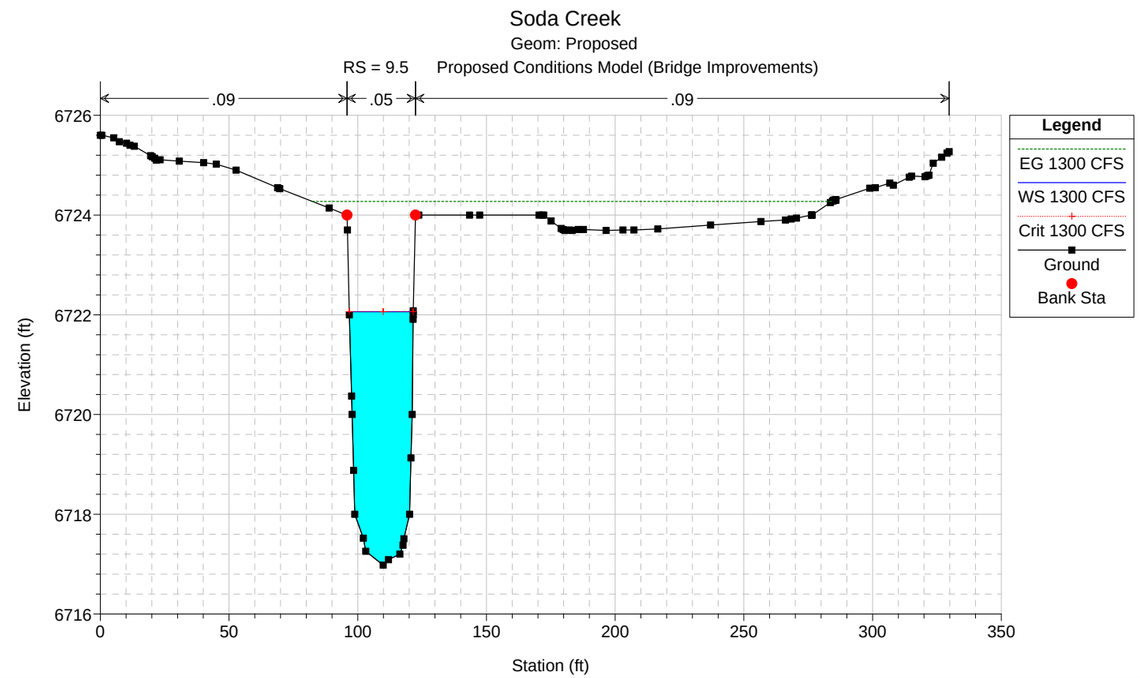

Soda Creek
Geom: Proposed
RS = 7 Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

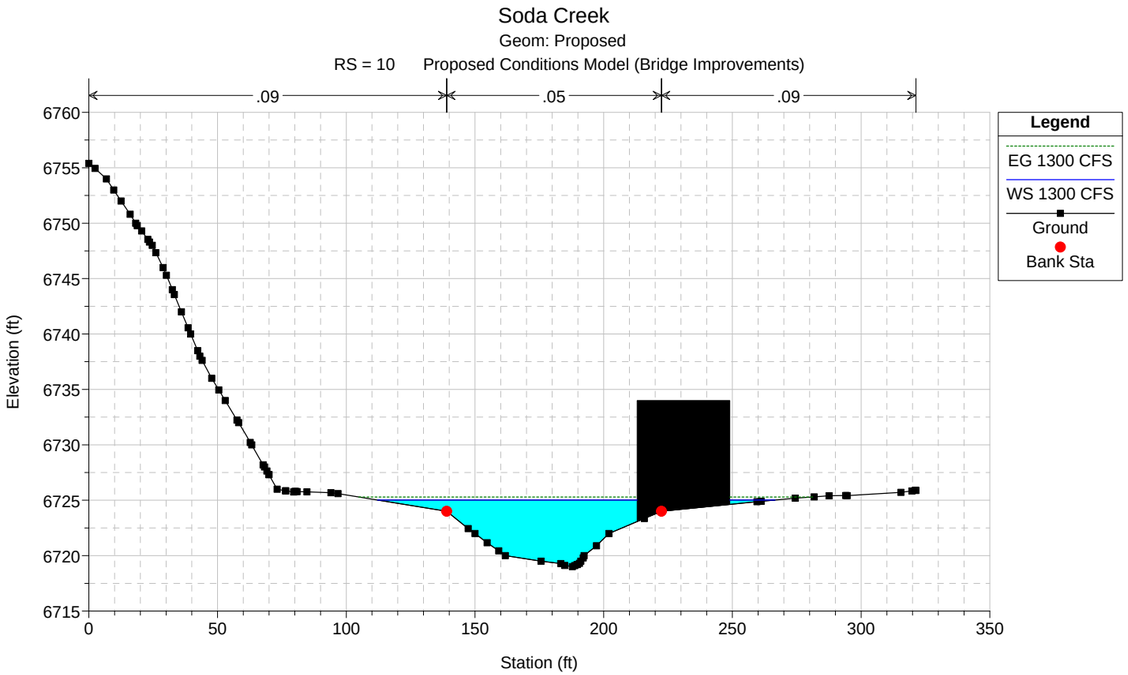

Soda Creek
Geom: Proposed
RS = 7.5 BR Pine Street Bridge - 32' Span Bridge Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

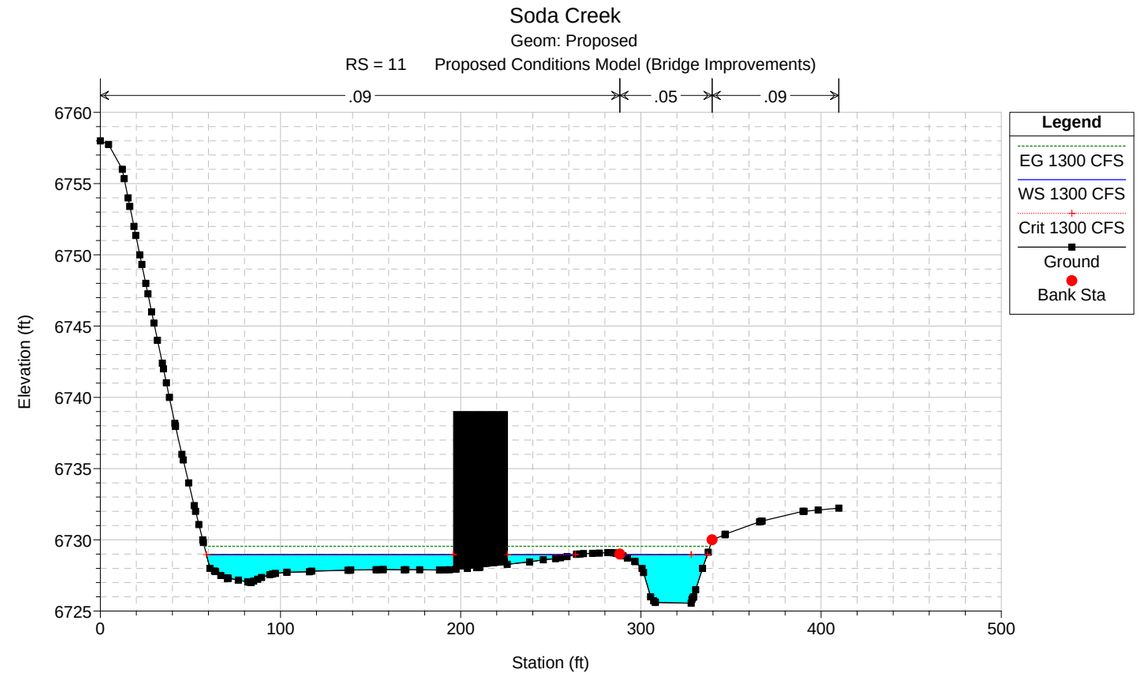

Soda Creek
Geom: Proposed
RS = 7.5 BR Pine Street Bridge - 32' Span Bridge Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

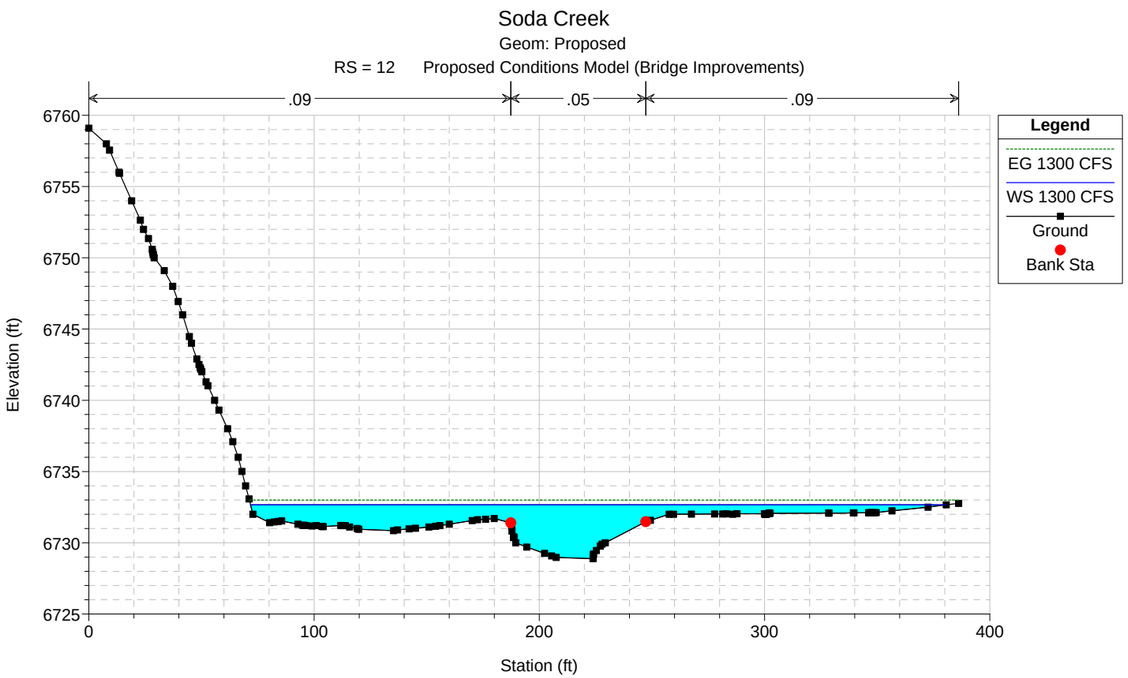

Soda Creek
Geom: Proposed
RS = 8 Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

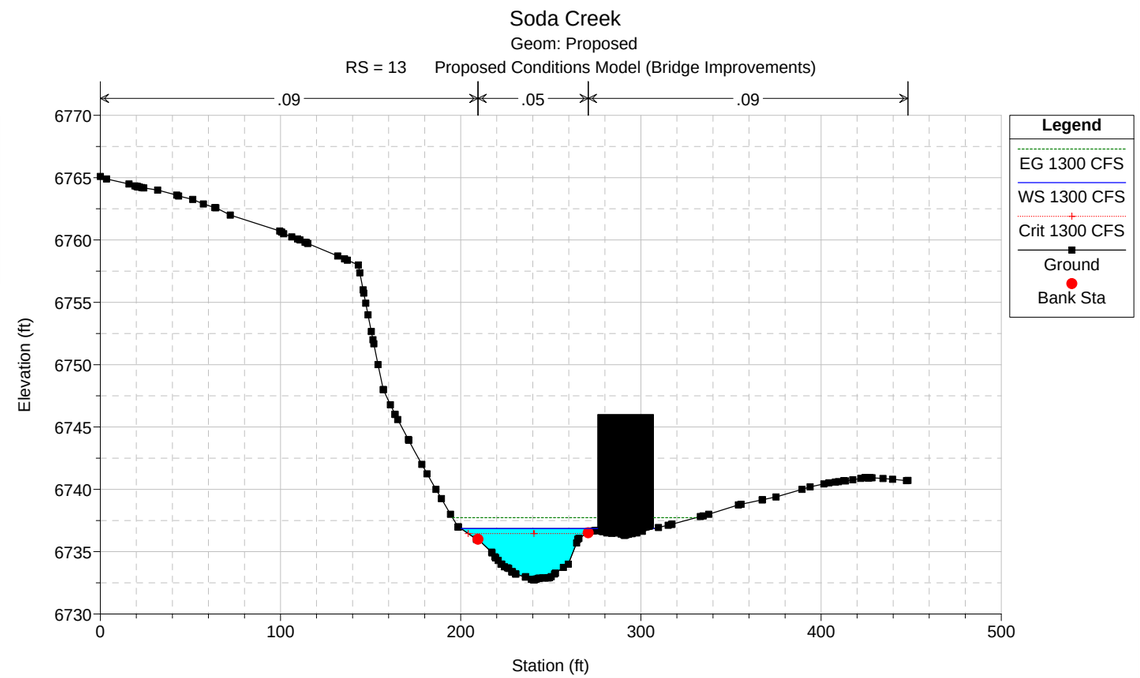

Soda Creek
Geom: Proposed
RS = 9 Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

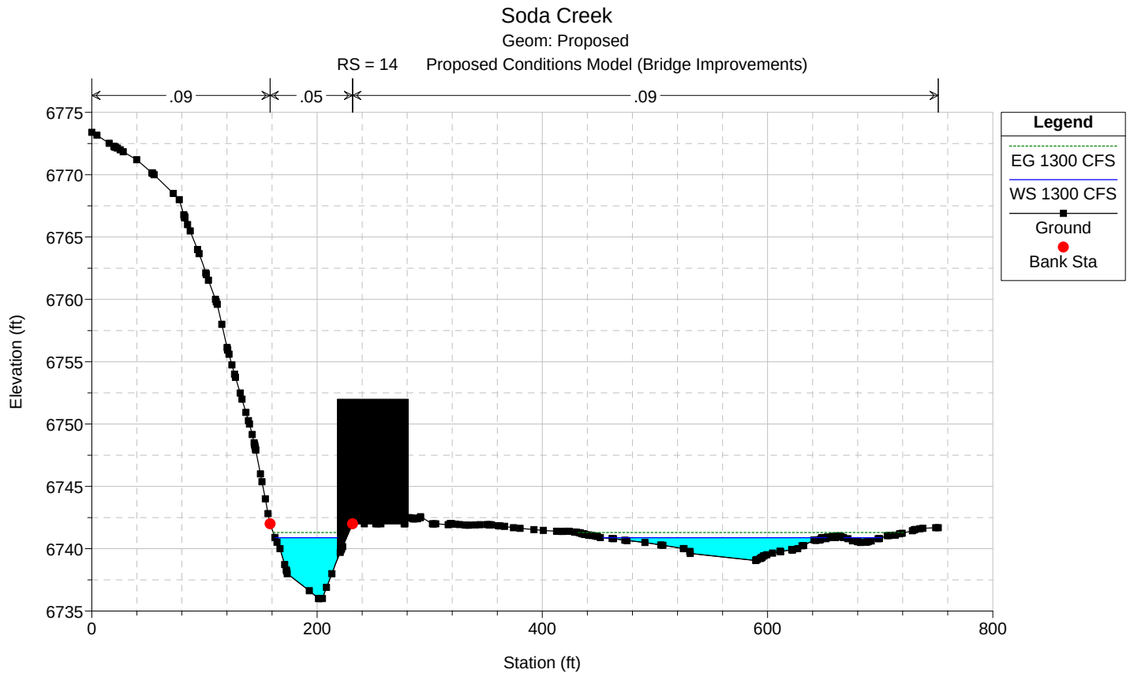

Soda Creek
Geom: Proposed
RS = 9.5 Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)

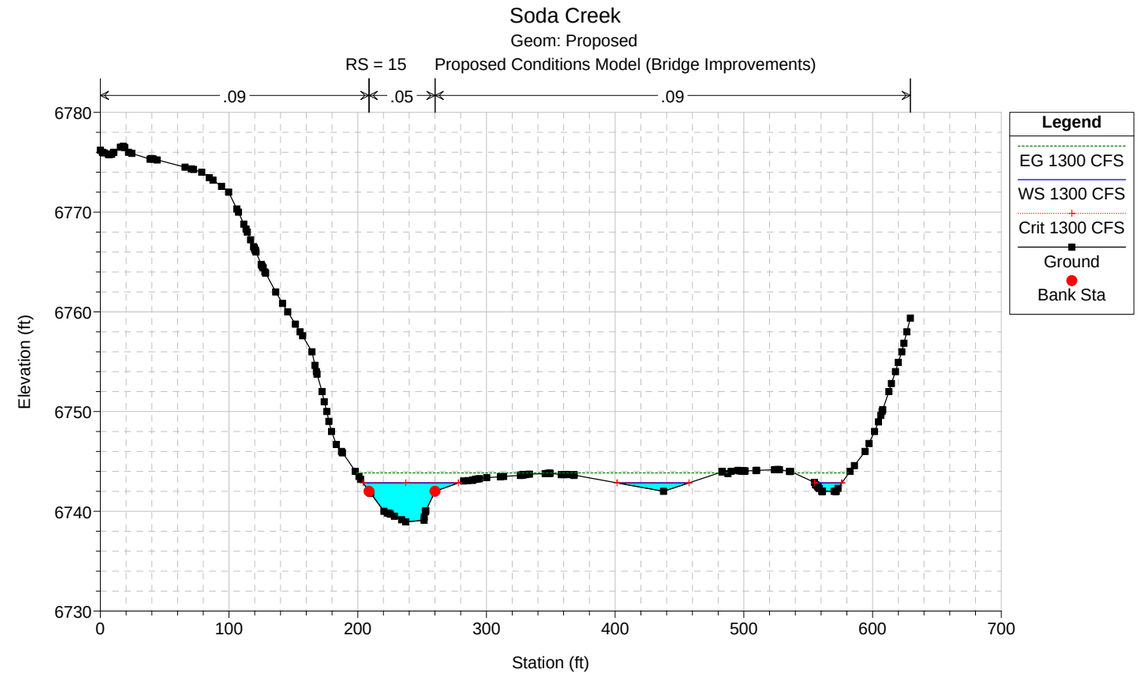

Soda Creek
Geom: Proposed
RS = 10 Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)

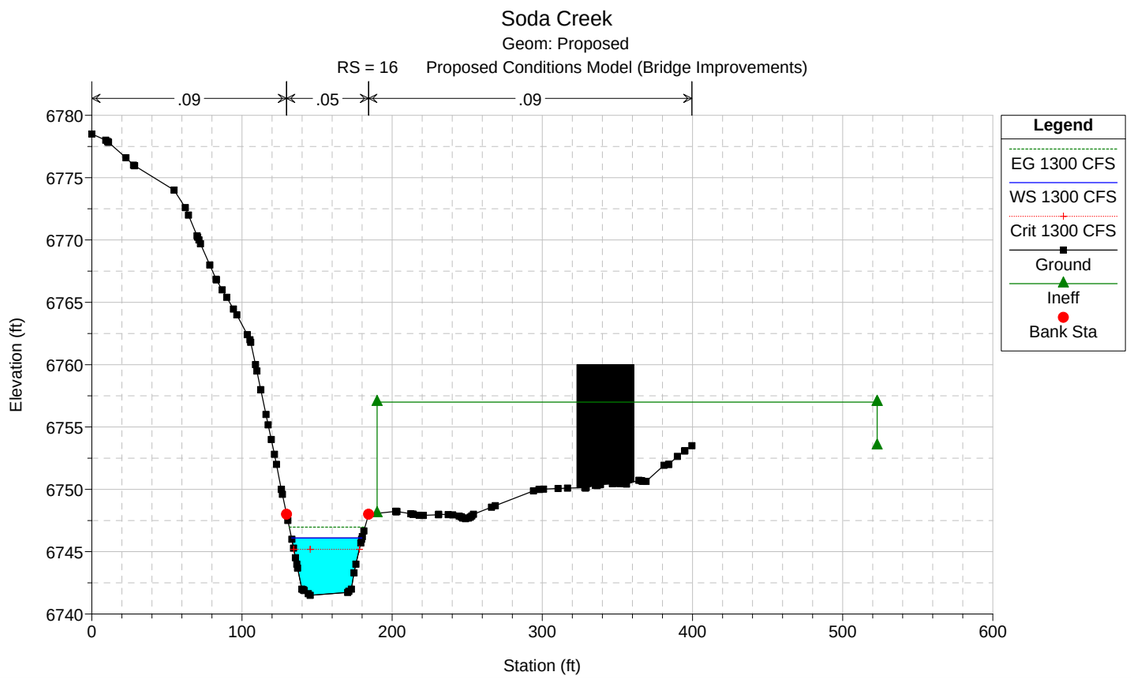

Soda Creek
Geom: Proposed
RS = 11 Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)

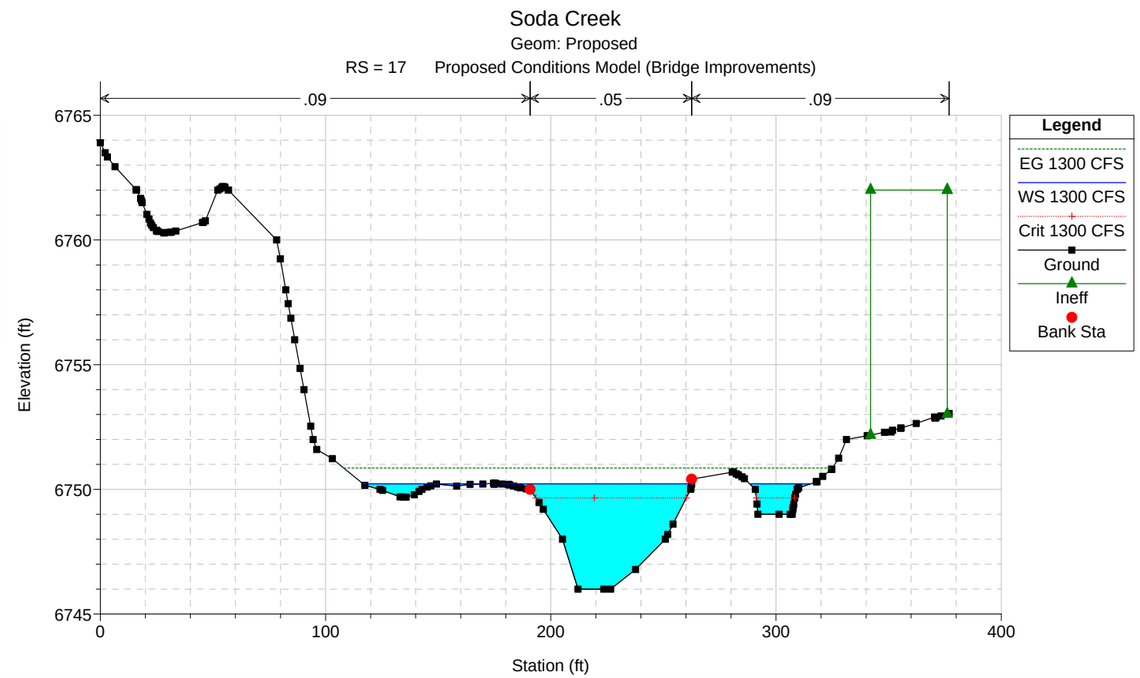

Soda Creek
Geom: Proposed
RS = 12 Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)

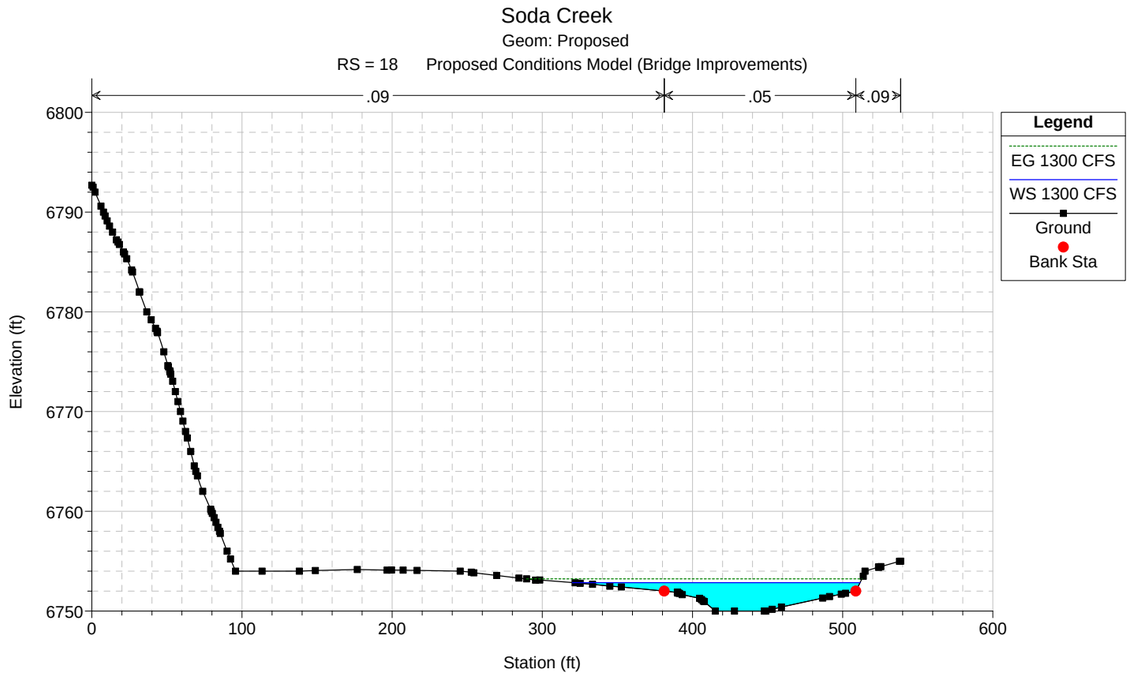

Soda Creek
Geom: Proposed
RS = 13 Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)

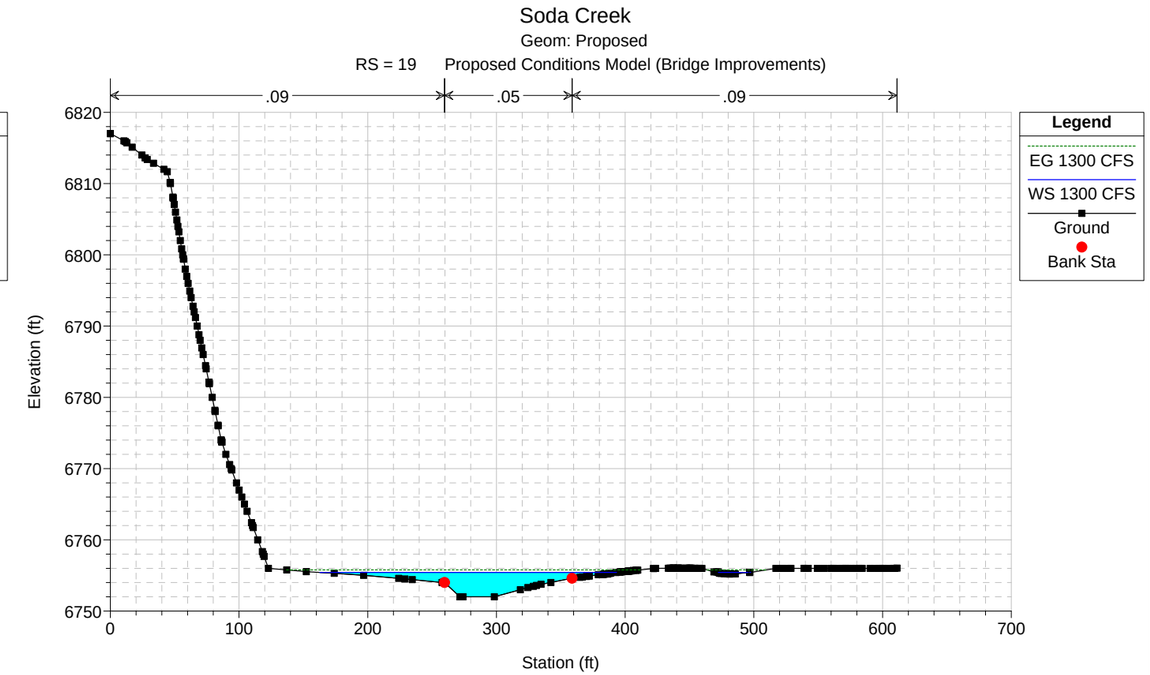

Soda Creek
Geom: Proposed
RS = 14 Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)

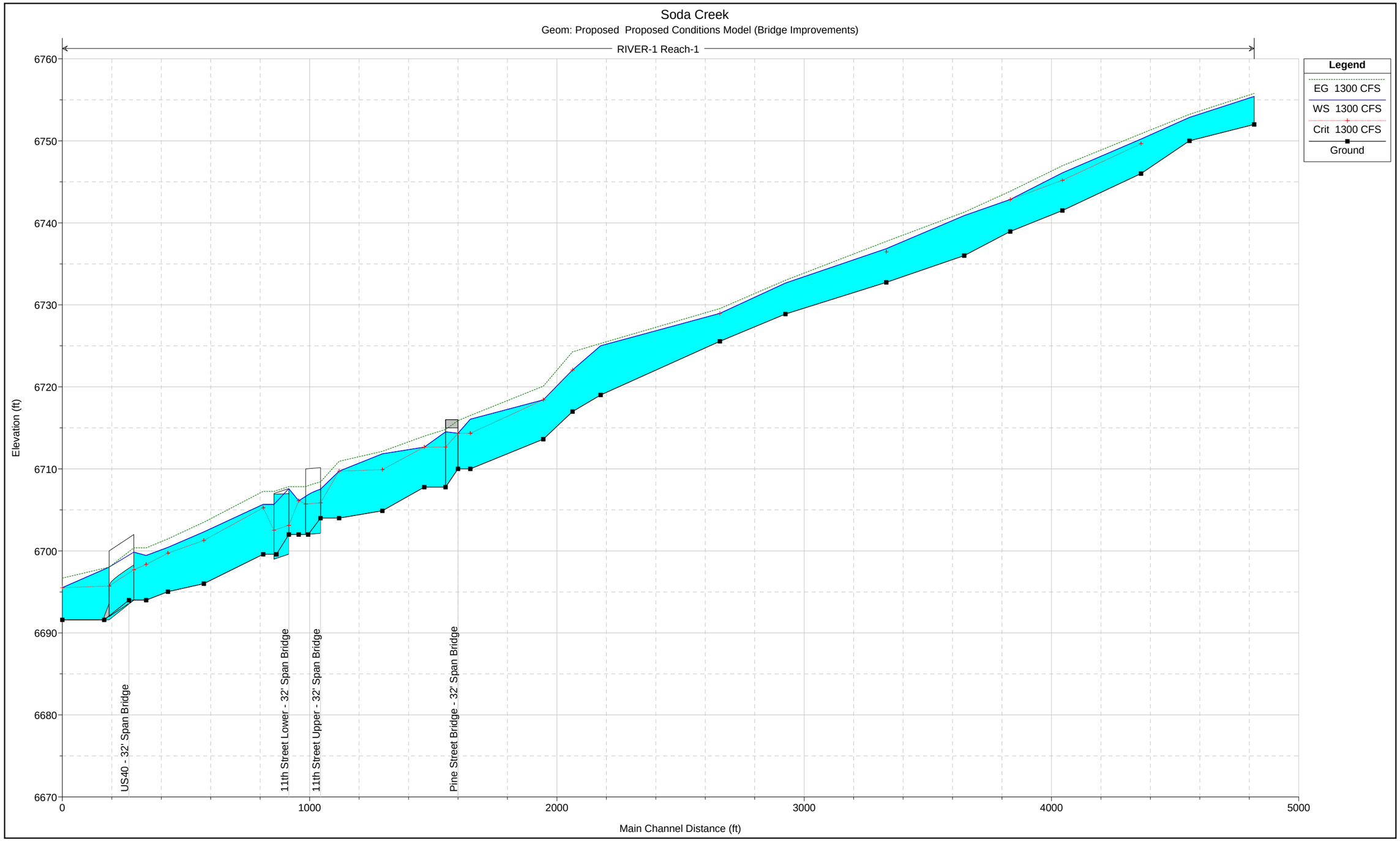

Soda Creek
Geom: Proposed
RS = 15 Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)


Soda Creek
Geom: Proposed
RS = 16 Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Soda Creek
Geom: Proposed
RS = 17 Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Soda Creek
Geom: Proposed
RS = 18 Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)


Soda Creek
Geom: Proposed
RS = 19 Proposed Conditions Model (Bridge Improvements)
.09
.05
.09
Legend
EG 1300 CFS
WS 1300 CFS
Ground
Bank Sta
Elevation (ft)
Station (ft)


Soda Creek
Geom: Proposed Proposed Conditions Model (Bridge Improvements)
RIVER-1 Reach-1
Legend
EG 1300 CFS
WS 1300 CFS
Crit 1300 CFS
Ground
Elevation (ft)
6760
6750
6740
6730
6720
6710
6700
6690
6680
6670
0
1000
2000
3000
4000
5000
Main Channel Distance (ft)
US40 - 32' Span Bridge
11th Street Lower - 32' Span Bridge
11th Street Upper - 32' Span Bridge
Pine Street Bridge - 32' Span Bridge