Development Accommodation Realignment Study – Riverton City

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Executive Summary

Riverton City recently purchased the last, undeveloped plot of land in their city. The current location has issues with erosion as Rose Creek is pushing towards its original location. The current capacity of Rose Creek is insufficient for the flow and during the peak times of the year, it floods the nearby intersection. In order to accommodate the new developments and to mitigate the problems currently facing that area, Riverton needs to realign Rose Creek back to its original flow path. Rose Creek was first realigned in the 1960's to accommodate central pivot irrigation methods. The proposed stream realignment given by our team has an even slope of about two percent through the site. The proposed channel has a floodplain to better imitate a natural channel that has been designed to withstand a flow of 500 cfs. The proposed layout and design will reduce the amount erosion, create space for new development, and reduce flooding.

The design process used Watershed Modeling Systems (WMS) to calculate the runoff into Rose Creek. Hydraulic Toolbox was used to analyze the existing cross sections and the proposed cross sections. ArcGIS was used to get slope profiles of the existing and proposed streams. Lastly, HEC-RAS will be used to analyze the existing cross sections and flow of the proposed realignment.

Table of Contents

Table of Figures

Introduction

The City of Riverton, Utah has embarked on a project to realign 2500 feet of a natural stream to support future development as part of an agreement with landowners. This land has been recently acquired by Riverton City from the Church of Jesus Christ of Latter Day Saints and has Rose Creek running through the property. For the Development Accommodation Realignment Study, our team has analyzed Rose Creek that runs through the city of Riverton and determined the best possible path to realign the stream in order to accommodate the future development. The section of Rose Creek that was analyzed lies just south 13400 S and east of the Mountain View Corridor in Riverton, Utah. It is proposed that this section of the creek be aligned to its natural path before it had been averted to the current position it now occupies. This realignment would create space needed for development and offer a design that would reduce erosion and flooding in the area.

To determine the design parameters needed in the new stream path, the following measures were taken. Initial watershed models were created in WMS to determine current 100 and 200 year peak flows. This analysis was performed to know the design capacity for new cross sections. The team also visited the current site. Coordinates, channel shapes, and measurements of the current creek path were taken in order to create existing cross sections and elevation profiles. With the existing elevations and cross sections, the existing conditions of the creek were determined.

As part of the objectives of the realignment study, a preliminary layout of the proposed stream was presented as the path of the new stream. Preliminary cross sections were designed to withstand a 500 cfs flow and analyzed using the hydraulic tool box and the stream bed slope from the elevation data collected. Other features such as a natural soil base or concrete base were recommended in the realignment as well. It was determined that a natural soil base with a small floodplain was the best design in the realignment plan.

The state of Utah requires different levels of authorization to alter a natural stream. The requirements to obtain authorization vary depending on the type of alteration. The entities responsible for authorizing the realignment of Rose Creek are the

US Army Corps of Engineers, the State of Utah, and Salt Lake County. A detailed outline of the requirements to obtain authorization from these entities is provided in the report.

Process

Current Conditions at Realignment Site

Current Path

Current conditions of Rose Creek have been observed on two separate occasions. The initial observation occurred October 13, 2016 with Trace Robinson from Riverton City. Upon walking the stream line, we observed large amounts of erosion despite the stream being currently dry. Rose Creek was visited again February 15, 2017 to observe the creek and also take various measurements of the channel. Further erosion had taken place as snow runoff has been flowing through the creek during the winter months. The heaviest amount of erosion has been taking place on the south side of the creek which is in the direction of the original stream path. It appears that the creek is trying to push its way back to its original path. Small puddles were sighted in different parts of the creek bed which indicates that the creek bed is not constant in its downward slope, creating areas of standing water.

Figure 1. Image of erosion taken in October, 2016

Site Conditions

The site is currently being used for agricultural purposes by the church of Jesus Christ of Latter Day Saints. Research and analysis indicate that Rose Creek was originally diverted in the 1960s to accommodate the circle irrigation used for farming. The current condition of Rose Creek is an ephemeral stream which remains completely dry for most parts of the year with the exception of flowing after heavy rains or melted snow runoff.

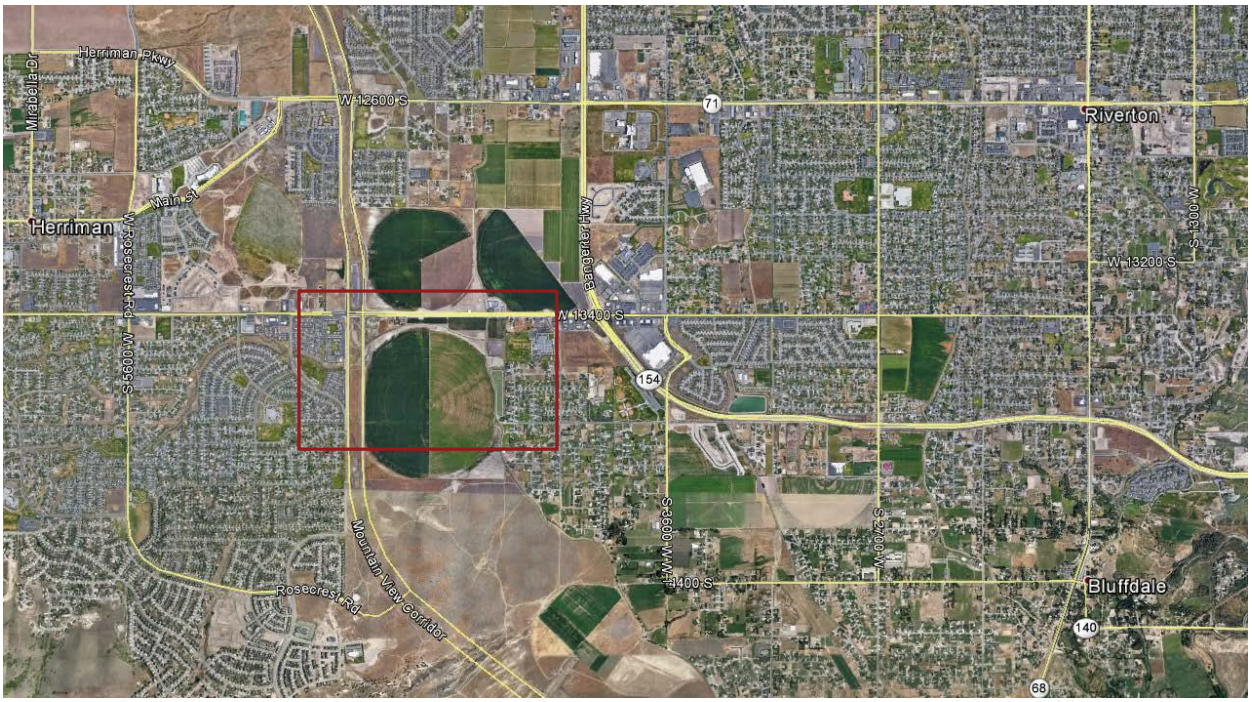

Figure 2. Site Location

Existing Cross Sections/Flow Rate

Three separate cross sections were taken of the creek in its current state to analyze the current state assuming 500 cfs flow rate (as requested by the city of Riverton). The assumed design flow rates will be later examined by creating watershed models in WMS to ensure a sufficient design for Rose Creek. The cross sections were analyzed using the hydraulic tool box and two of the three cross sections were found to have super critical flow based on the froude number. Based on observations the creek width was consistently 18-20 feet wide at the top and 8-10 feet deep, while the cross sections of the stream matches that of cross section 2 (see Appendix for hydraulic tool box analysis of cross-sections) for more than two-thirds of the channel distance. The design flow given from Riverton City was 500 cfs, watershed modeling is being done to verify that number and will be explained in the following sections.

Figure 3. Locations of original cross sections for analysis

WMS Watershed Model

Methodology

The method for determining the flow rate for Rose creek at the above site will be to use WMS watershed modeling and regression equations. The watershed was found to be 14.97 square miles for an output point at the end of the culvert on the west side of the lot. The watershed is a large area since the output point under analysis is far downstream of rose creek. Much of the watershed is observed to be urbanized with some rural areas further up in the mountains. The flow rate was determined with the help of WMS through regression equations which will be explained in the following section.

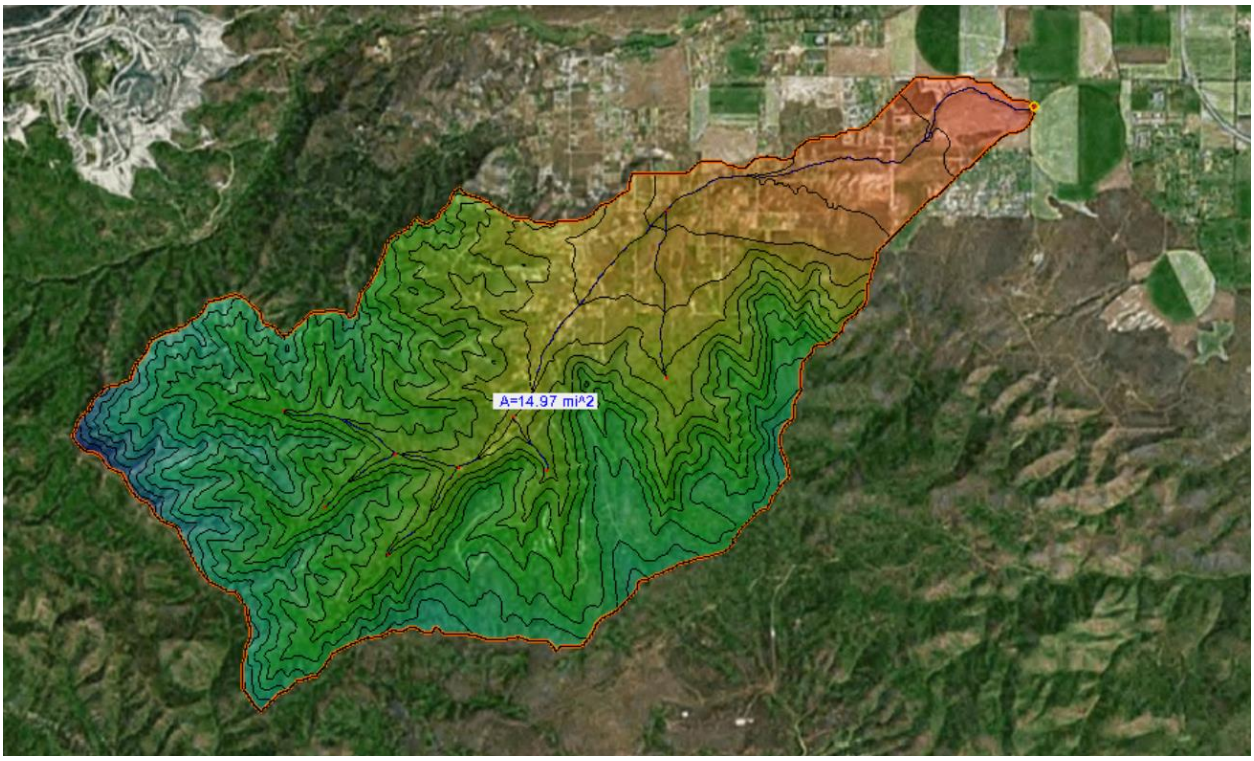

Figure 4. Watershed for Rose Creek

Computing Flow Rate

Preliminary flow rates were determined by delineating the watershed model obtained in WMS, and using the regression equations provided in the program. The Riverton site is in region 2 (rural) of Utah and that equation was used to find flows for the 2, 5, 10, 25, 50, 100, 200, and 500-year recurrence. As seen in Table 1 our flow requirements are well below 500 cfs for a rural situation. Since a large portion of the watershed is an urban area, an urban regression equation is need to accurately determine the flow. Since the national urban equation in WMS does not work, an urban equation was selected from page 8 of "Nationwide Summary of U.S. Geological Survey Regional Regression Equations for Estimating Magnitude and Frequency of Floods for Ungaged Sites, 1993." These values will be used to verify that the 500 cfs flow given for design is conservative, and therefore adequate.

Table 1. Values based on regression equation for Utah region 2 with and area of 14.9 sq. miles and 24 in. annual precipitation

Type	Peak [cfs]	Recurrence [years]	Equivalent Years	Error [%]
Rural	32	2	0.9	71
Rural	56	5	1.6	58
Rural	75	10	2.5	53
Rural	95	25	3.7	51
Rural	118	50	4.6	50
Rural	138	100	5.4	50
Rural	158	200	6.1	51
Rural	190	500	6.8	52

Proposed Realignment Path

New Design Path

The new design path was chosen to match the original path of Rose Creek before it was diverted. To accurately place the proposed path, old maps were found in the Harold B. Lee Library that show where Rose Creek was originally located before diversion. Riverton City also hired surveyors to design a proposed path with elevations as close as possible to the original path. Topographic maps were studied as well which indicate where the original path most likely was. Using Google Earth and ArcGIS, the team mapped out the new proposed path and created an elevation profile for the new layout. The new elevation data provided shows that a constant downward slope between 1.4-2.2% is achieved.

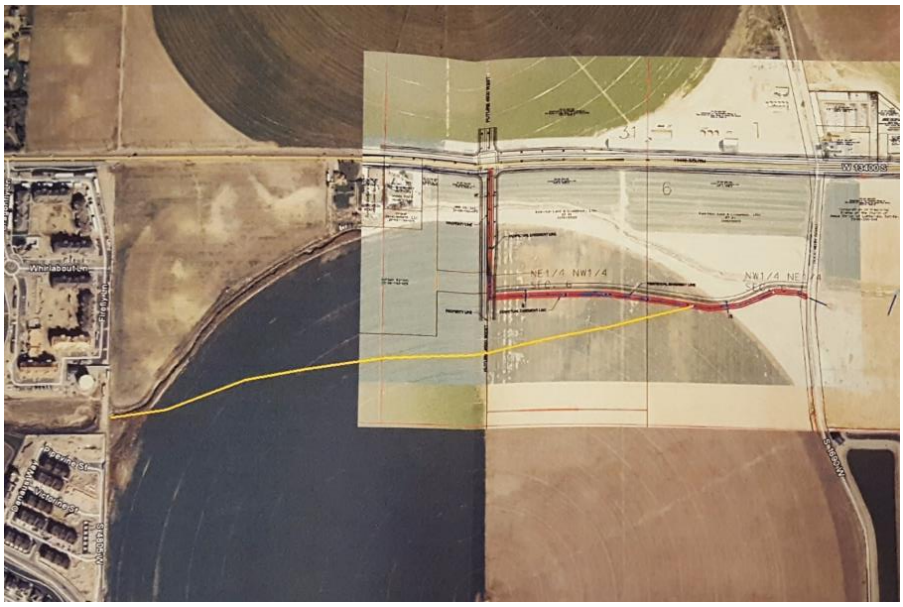

Figure 5. Proposed new path for Rose Creek

Design Cross Sections

Future work to be performed.

Creating Model in HEC-RAS

The team sat in on two classes about HEC-RAS taught by Dr. Rollin Hotchkiss. The first class covered the theory behind HEC-RAS and about the Army Corps of Engineers that runs the program. The second class went through the steps of using HEC-RAS in a hands-on learning experience. During the class a sample stream was mapped and cross sections were added. HEC-RAS will be used to layout the new path for Rose Creek. The designed cross section will be place along the path, and a model will be created to determine the how the new stream will work. This design will help in determining the performance of Rose Creek, and if a natural channel will be sufficient for the stream flow.

Permitting Requirements (specific to final design)

Future work to be performed.

Conclusions

Data was collected and analysis was performed to design a new realignment for Rose Creek. It was determined from WMS that the 500 cfs flow will be more than adequate for the design flowrate of the new Rose Creek based on the rural regression equations. The design reflects an effort to bring the stream back to its original state by finding the natural course of the creek and designing the stream with floodplains. After the design is reviewed and approved by Riverton, the permitting process will be reviewed and summarized.

Conclusion will be finished with future work.

Appendices

Watershed modeling regression data (Region 2 rural)

Input Parameters:

State:	Utah
Crippen and Bue Region:	Region 2
Region:	Region 2

Variable values:

Variable Name	Abbreviation	Value	Units	Minimum	Maximum
Drainage Area	DRNAREA	14.971321	square miles	2.14	84.1
Mean Annual Precipitation	PRECIP	24	inches	16.5	53.7

Output:

Type	Peak [cfs]	Recurrence [years]	Equivalent Years	Error [%]
Rural	32	2	0.9	71
Rural	56	5	1.6	58
Rural	75	10	2.5	53
Rural	95	25	3.7	51
Rural	118	50	4.6	50
Rural	138	100	5.4	50
Rural	158	200	6.1	51
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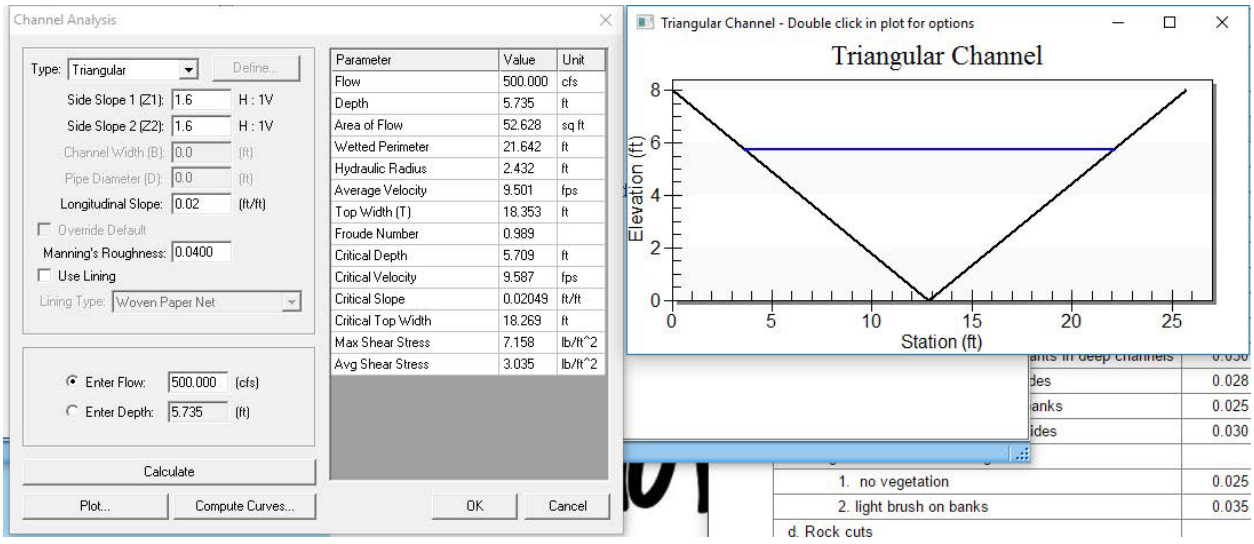
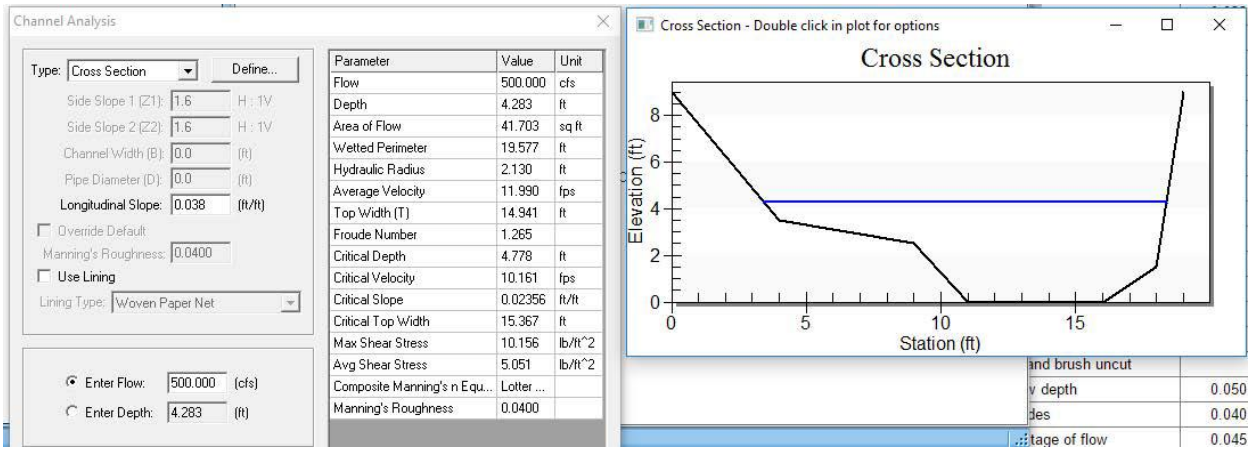
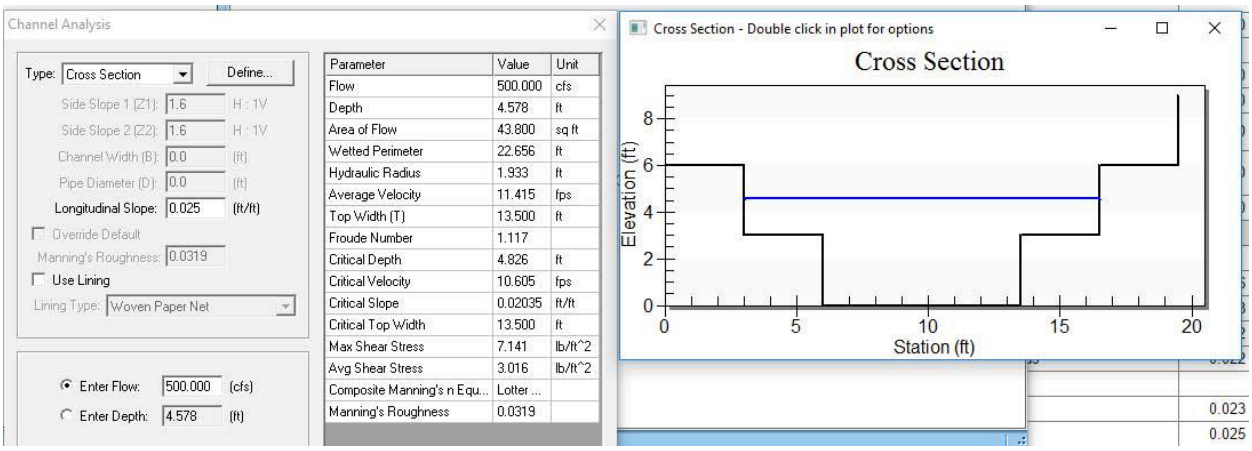
Original cross section 1



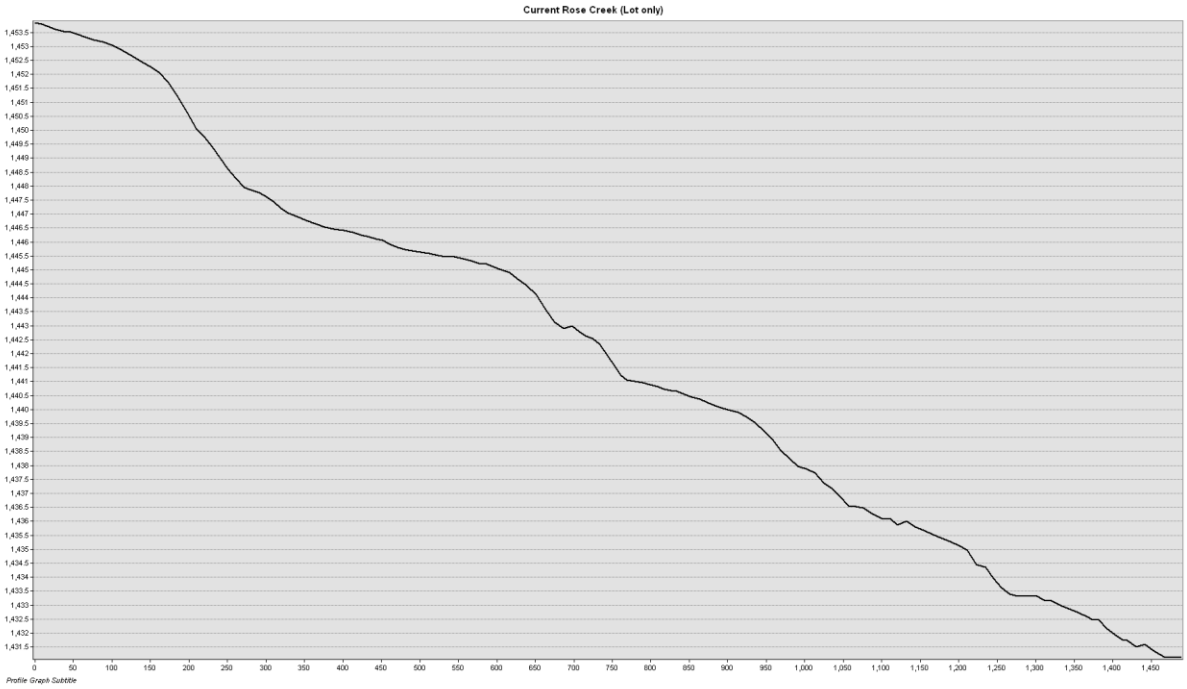
Original cross section 2



Original cross section 3



Current elevation profile of rose creek



Elevation profile of new proposed path