APPENDIX C

Alternative 1 – Drainage Alternatives

Memorandum

WOOD RODGERS
BUILDING RELATIONSHIPS ONE PROJECT AT A TIME

To: John Norman, Brookfield Residential

CC: Dave Krolick, ECORP
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From: Paul Klein, P.E.

Date: April 25, 2019

Subject: Amoruso Ranch Specific Plan – Drainage Alternatives

OVERVIEW AND SUMMARY

One of the key elements that significantly influenced the development concepts for the Amoruso Ranch Specific Plan (ARSP) was the ability to provide drainage and flood control for the proposed development area. The drainage of the Amoruso Ranch property is controlled by the topography of the adjacent parcels and the established drainage courses within the project vicinity. The design for the developed conditions grading will require matching existing edge conditions (where the development shares a coterminous boundary with other parcels), as well as providing positive drainage paths while minimizing impacts to areas identified within the environmental analyses (within the "preserve area").

In order to meet the original objectives for the project, three alternative drainage solutions were investigated:

1) Conventional Piping System with Headwall Outlets into Preserve Area;

2) Pumping Station with Discharge to University Creek; and

3) Conventional Piping System with Discharge Directly to University Creek (southwest corner of development area) (both with and without an open channel)

This information was used to support the approved Drainage Master Plan for the project.

The open channel combined with a conventional piped system was selected as the best feasible alternative based on a number of factors, including the following:

1) A conventional piping system would require significant changes in grade (import of fill material of approximately 900,000-cubic-yards) to the project site, more drainage outfalls, and grading through the currently proposed "preserve area" to provide positive drainage flow from the project site, increasing the direct and indirect impacts;

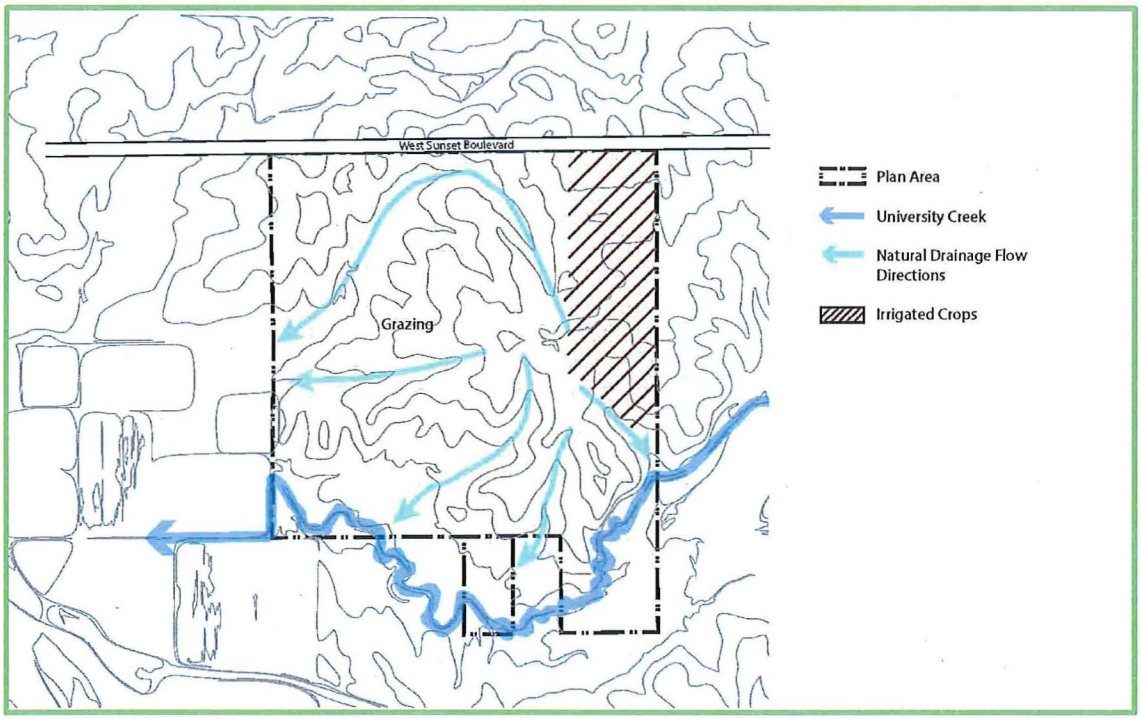
2) A drainage pumping station has significant initial capital and long-term operation and maintenance costs; and

3) City of Roseville's policy is to avoid drainage pump stations because of significant flood liability risks in addition to the cost implications noted above.

Included within this memorandum are the following supporting information: existing drainage pattern information; and discussion of alternative drainage solutions investigated.

EXISTING DRAINAGE PATTERNS

In general, the existing undeveloped land is gently rolling terrain generally trending to the west and south. Minor drainages flow in a radial pattern from a slight rise in the northeast quadrant of the property. The elevation changes gently from the northeast down to the southwest as shown in the graphic below from the Drainage Master Plan. The majority of the Amoruso Ranch drains towards the existing University Creek drainage course. (This is described in more detail within the Drainage Master Plan prepared for the City of Roseville).



ALTERNATIVE DRAINAGE SOLUTIONS

Managing drainage for the overall development requires modifications in the existing drainage patterns. Overall, a majority of the interior drainage from the project site will be collected within a conventional storm drain system (installed within the street and circulation network) and conveyed toward the south and southwest to outlet for conveyance into University Creek and ultimately Pleasant Grove Creek.

As a result of the limited elevation differential across the project site, and the necessity to minimize the impacts to the areas identified with the environmental analyses within the designated "preserve area", the drainage and flood control system serving ARSP is constrained.

In developing the drainage and flood control system for ARSP, and working with the topographic constraints of the project area, we identified three approaches to construct a drainage and flood control system. These include:

1) Conventional Piping System with Headwall Outlets into Preserve Area;

2) Pumping Station with Discharge to University Creek; and

3) Conventional Piping System with Discharge Directly to University Creek (southwest corner of development area)

These approaches are discussed in more detail below:

Conventional Piping System with Headwall Outlets into Preserve Area

In developing a drainage system utilizing conventional storm drain pipes and outlets with headwalls into natural drainage courses, it was determined that a number of headwall outlets would be required to outlet flow from the development area to University Creek. This approach would require the addition of a minimum of two drainage pipe outlets with headwalls along the southern boundary of the project site into the preserve area.

The combined flowrate from these outlets into the preserve area is approximately up to 400-cfs during a 100-year storm event. This results in a concentrated flowrate of up to 100- to 200-cfs from each of the outlet structures across the preserve area for the flow to reach the University Creek drainage, depending on how the system is configured.

This approach was not considered acceptable to the City of Roseville and the Developer for the following reason:

1) The introduction of high concentrated flowrates (100- to 200-cfs, per outlet) across the preserve area are inconsistent with the intent of preservation of environmental resources within the area and would increase the environmental impacts.

As a result, an alternative to look at conveying flows directly to University Creek near the southwest corner of the project was developed and is discussed as part of the subsequent alternative approaches presented below.

These same issues and conclusions from the original project evaluation exist with EIS Alt 1 and 404(b)(1) Alt. 3. Therefore, this is not considered a feasible solution for the suggested EIS Alt 1 or 404(b)(1) Alt. 3.

Storm Water Pumping Station with Discharge to University Creek

An alternative method of providing drainage and flood control for a project like ARSP, where site elevations do not allow a conventional piped drainage system, is the implementation of a storm water pump station. A storm water pump station was considered for the ARSP project.

The storm water pump station would require approximately 0.5-acres of land for the pumping facility and another approximately 5- to 8-acres of land for the flow regulating basin. We reviewed the pumping station alternative with the City of Roseville and were instructed to develop a different feasible solution. The City of Roseville would not approve of a storm water pumping station for a number of reasons:

1) A storm water pumping station introduces a level of liability for flooding damage if there were to be a failure of the pumping station. This liability does not exist with a gravity flow system.

2) A storm water pumping station significantly increases annual costs for the City for ongoing operations and maintenance.

3) The City has routinely avoided storm water pumping stations throughout their system for the reasoning listed above and did not intend to deviate from their guidelines. The City stated that the project would not meet City requirements if we included a storm water pumping station when another feasible alternative exists.

4) It was estimated that the initial capital cost for a storm water pumping station of this magnitude to serve ARSP (excluding land value) would be on the order of $6,000,000 to $8,000,000.

For the reasons listed above, this alternative was found to not be an acceptable alternative for the ARSP Project by both the City of Roseville and the Developer.

Regardless of the alternative developable boundary considered for the project, the City's rejection of a storm water pumping station eliminates this option from consideration for all alternatives including EIS Alt 1 and 404(b)(1) Alt. 3.

Conventional Piping System with Discharge Directly to University Creek (southwest corner of development area) – Option 1: Completely Piped System

A third alternative to provide drainage and flood control for ARSP was developed. This alternative looked at intercepting flow along the southern boundary of the development area and conveying it into University Creek just off-site of the project near the southwest corner of the development.

Initially, we looked at a piped solution. A piped solution to carry between 100- and 400-cfs would require multiple large diameter storm drain pipes (or construction of a pre-cast or cast-in-place multiple box system). For a piped alternative, the minimum diameter pipe for 100-cfs capacity is 8-ft, with a minimum slope of 0.017%. Therefore, between one and four 8-ft diameter pipes would be required for the project to convey up to the 400-cfs.

The point of connection with University Creek has an existing creek invert elevation of 75.72-ft. The ground elevations proposed along the southern boundary of the development, where this pipe would be located, are approximately 84-ft. The table shown below provides information on the resultant approximate ground elevation that would be required for a piping system to be installed.

A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*	*L*	*M*
Maximum No. Pipes	Diameter, ea. (ft)	Approximate Length (ft)	Max Flowrate per Pipe (cfs)	Min. Slope (ft/ft)	Slope Elevation Rise (ft) (C*E)	Pipe Outside Diameter (ft)	Min. Pipe Cover (ft)	Resultant Grade Differential at Pipe Inlet (F+G+H)	Creek Tie-In Elevation (ft)	Required Grade at Pipe Inlet (ft) (I+J)	Site Grade at Pipe Inlet (ft)	Actual Grade Differential (ft) (K-L)
4	8	2,150	100	0.00017	0.36	9.5	4	13.86	75.72	89.58	84	5.58

As shown on the table, the site elevation would be required to be raised 5.58-ft in order to accommodate a piped solution to convey the drainage along a portion of the southern boundary to the existing University Creek.

Even raising the developed site area an average of just one-foot, through the importation of fill material, results in nearly 900,000-cy of fill material being required. Since there is not the availability of borrow soils material within or directly adjacent to the project site, the material would need to be trucked in from a remote location.

Trucking in over a 900,000-cy of earth material would result in significant environmental issues, including Green House Gas emissions, traffic, etc. In addition, this alternative increases the overall project cost in excess of $13,000,000.

For the following reasons it was concluded that a completely piped system connecting to University Creek was not a feasible alternative:

1) A piped system would require raising the site elevations up to 5.6-feet, resulting in the importation of well over 900,000-cy of fill material.

2) Multiple parallel large diameter storm drain pipes would be required to implement, or an even more costly multi-box drainage system would be required, in addition to the significant importation of fill material.

3) Costs associated with this alternative add in excess of $13,000,000 to the projected project budget.

4) Additional environmental/preserve impacts for construction and long-term operations and maintenance.

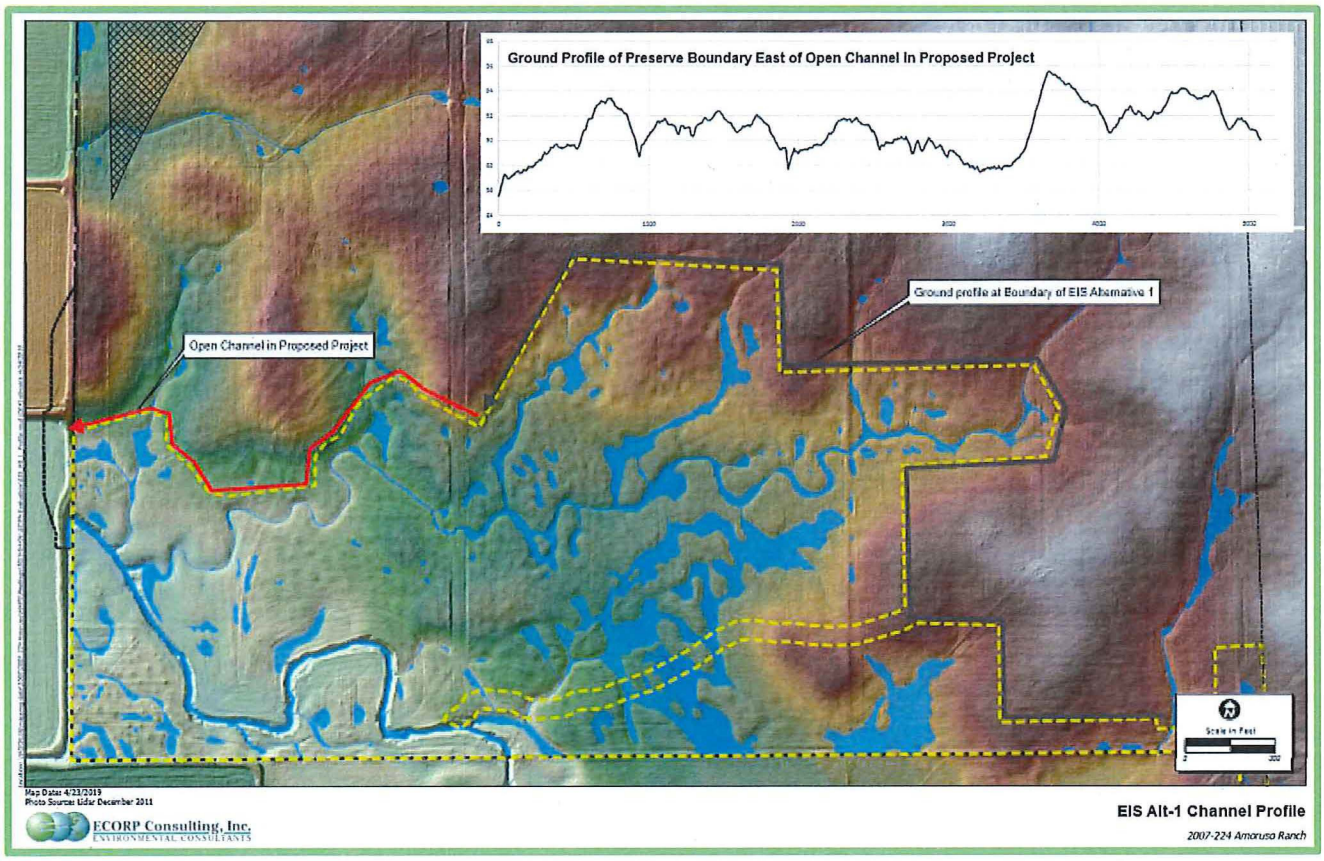
As with the original project analysis for a completely piped system, EIS Alt 1 and 404(b)(1) Alt. 3 would also require similar quantities of fill to allow a completely piped system to work and convey flow to an outlet point at the southwestern corner of the project. Additionally, there is inadequate grade differential for a gravity flow pipe system to be constructed under the preserve area through trenchless construction methods (i.e. jack & bore) to meet the project requirements and outlet at the proposed University Creek point of connection.

Conventional Piping System with Discharge Directly to University Creek (southwest corner of development area) – Option 2: Piped System <u>with Open Channel</u>

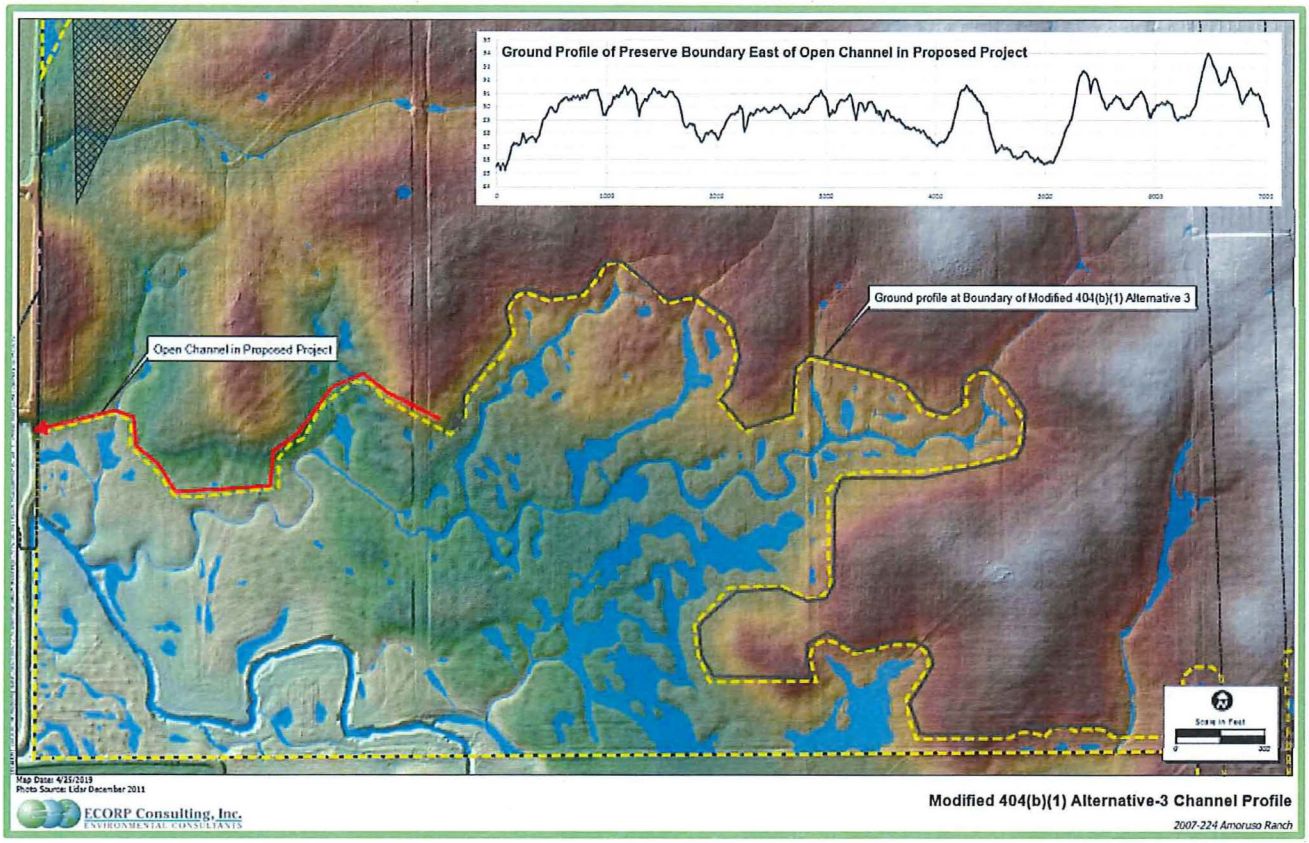
Based on the analysis of the third approach detailed above, a variation for the originally proposed project was developed to combine a piped system with open channels to convey flow adjacent to the development directly to University Creek. The open channels were determined to be beneficial as they can convey storm water in a similar manner to a piped system; however, to convey the same flow as a pipe they can have a shallower depth dimension, with a wider width, which makes open channels a preferred alternative when elevation constraints are present. These features of open channels allow them to work with the existing and proposed site grades of the original design alternative without the need for extensive importation of fill material.

Under the EIS Alt 1 and 404(b)(1) Alt. 3, the feasibility of extending the channel system around the proposed new southern limits of the project was reviewed. For clarification, as previously stated, EIS Alt 1 and 404(b)(1) Alt. 3 have the same constraints with trying to maintain all drainage flow in a piped system as was previously discussed. Therefore, the implementation of channels for these alternatives would need to be considered.

The current inlet elevation at the start (eastern end) of the channel along the southern preserve boundary of the originally proposed project is 77.84-ft. The channel has a proposed minimum slope of 0.10%. For EIS Alt 1 an additional approximately 5,000-ft of channel would be required to follow the edge of the proposed development and not cross through the preserve area. The figure shown below (EIS Alt-1 Channel Profile) includes a profile of the ground surface along the southern edge of the EIS Alt 1 (shown in gray on the figure) beginning at the point of connection with the originally proposed channel system (shown in red on the figure).



For 404(b)(1) Alt. 3 an additional approximately 7,000-ft of channel would also be required to follow the edge of the proposed development and not cross through the preserve area. The figure shown below (Modified 404(b)(1) Alternative-3 Channel Profile) includes a profile of the ground surface along the southern edge of the 404(b)(1) Alt. 3 (shown in gray on the figure) beginning at the point of connection with the originally proposed channel system (shown in red on the figure).



As can be seen on the surface profile, the elevations along either the EIS Alt 1 or the 404(b)(1) Alt. 3 boundary do not lend themselves to a gravity flow scenario due to a number of high and low points along the profile. Two options were considered for drainage for this alternative:

1) Install intermediate drainage outlets; or

2) Alter the ground profile to facilitate gravity flow.

1. ***Install intermediate drainage outlets:*** Based on the surface profile shown in the previous figure, the inclusion of three additional drainage outlet structures would be recommended to provide drainage of the development area. These additional drainage outlets would discharge to University Creek. These additional drainage outlets would need to be located within the preserve area. The discharged flow would be conveyed through and across the preserve, and the environmental resources, in order to reach the University Creek drainage course. With the volume of flow that would need to be conveyed through the drainage outlet/headwall structures (in excess of 100-cfs, as previously discussed) it has consistently been considered an incompatible solution with the desired protection of environmental resources and was eliminated from further consideration.

2. ***Alter the ground profile to facilitate gravity flow:*** Altering the ground profile along the southern edge of EIS Alt 1 or 404(b)(1) Alt. 3 requires a significant amount of earthwork in the area of the suggested southern boundary and up into the development area to recontour the site to allow gravity flow along the boundary and provide a drainage connection with the channel included within the proposed project.

The proposed invert elevations of the on-site development area storm drain piping, proposed under the original project alternative, that would outlet into the proposed extension of the southern channel along the EIS Alt 1 or 404(b)(1) Alt. 3 boundary, are at a lower invert elevation than the minimum allowable channel invert elevation would be if it was extended along the EIS Alt 1 or 404(b)(1) Alt. 3 boundary. Therefore, this requires additional fill to be brought into the project site in order for the on-site storm drain piping system as proposed to be raised to a higher elevation that will allow discharge into the EIS Alt 1 or 404(b)(1) Alt. 3 extended channel.

In addition, the extension of the channel requires additional acreage to be taken from the developable area to provide area for the drainage channel.

Engineering estimates for both the earthwork quantities and acreage required for the drainage channel, embankments, setbacks, etc. were estimated.

A) ***Earthwork requirements:*** In order to provide gravity flow of drainage along the southern boundary of the suggested EIS Alt 1 project, it is estimated that approximately 480,000 cubic-yards of fill material would be required[1]. This material would be required to come from an unknown off-site location and be trucked to the project site. Similar to discussions previously presented within the memorandum, trucking in a significant amount of fill material would result in significant environmental issues, including Green House Gas emissions, traffic, etc. In addition, this alternative increases the overall project cost in excess of $7,000,000.

B) ***Developable Acreage Impacts:*** The area estimated for the channel, and its associated requirements, along the southern boundary of the suggested EIS Alt 1 project is estimated to be 10- to 15-acres and for 404(b)(1) Alt. 3 it is estimated to be between 14- to 20-acres.

Based on the additional impacts required to provide drainage through open channels for the suggested EIS Alt 1 boundary or 404(b)(1) Alt. 3 boundary (grading, additional drainage outlets through the preserve, additional lost developable acreage to accommodate the channel, environmental challenges with importation of fill, and/or the additional financial impacts), these alternatives are not considered feasible.

CONCLUSION

The open channel combined with a conventional piped system (for the originally proposed project configuration) was selected as the best feasible alternative based on a number of factors, including the following:

1) A conventional piping system would require significant changes in grade (import of fill material) to the project site, more drainage outfalls, grading through the current "preserve area" to provide positive drainage flow from the project site, increasing the direct and indirect impacts;

2) A drainage pumping station has significant initial capital and long-term operation and maintenance costs; and

3) City of Roseville's policy is to avoid drainage pump stations because of significant flood liability risks in addition to the cost implications noted above.

[1] Earthwork was estimated based on an approximate 150-acre +/- area of the development that would need to have grades elevated to provide positive gravity flow drainage from the on-site storm drainage system into the extended open channel along the EIS Alt 1 boundary. Grade adjustments within this area would vary between 1- and 3-feet (for an average of 2-feet). 2-feet of fill across 150-acres is equivalent to 484,000-cy.