24015 ~~~

Application for Conditional Letter of Map Revision (CLOMR)
Damonte Ranch Phase V and Bella Vista Ranch PHASE 1
City of Reno, Nevada

Prepared for:
Centex Homes

Prepared by:
QUAD KNOPF

Revised June, 2006
February, 2006
Job No. N0432

Quad Knopf

PROFESSIONAL ENGINEER - STATE OF NEVADA
RALPH M. HOGOBOOM
Exp 6/30/07
CIVIL
No 11813

8/22/06

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

1.0 INTRODUCTION

This narrative has been prepared to accompany an application for a Conditional Letter of Map Revision (CLOMR) for portions of the Damonte and Bella Vista Ranches. These ranches are located in the Southeast Truckee Meadows, south of Reno, Nevada (Figure 1) and are in the process of being developed. The two projects are adjacent to each other. The properties lie within the City of Reno's jurisdiction and within the Southeast Truckee Meadows Master Plan area.

The Southeast Truckee Meadows Specific Plan area lies within the Steamboat Creek hydrologic basin. In addition to Steamboat Creek, flows from two branches of Whites Creek and flows from the Virginia Range affect this area. Regional detention facilities and major channel systems provide conveyance and control of 100-year storm waters. The area covered by this study is found on Panels 3178, 3179, 3186 and 3187 of FIRM Number 32031C3178 E, Washoe County, Nevada and Incorporated Areas. The most recent floodplain adjustments were done under "An application for Letter of Map Revision (LOMR) for the Damonte Ranch/Double Diamond Ranch Regional Flood Control Improvements" (September 2004) under FEMA Case No. 05-09-0105P. It was approved by FEMA in October 2005 (see panels 3186 and 3187 in Appendix E). The original CLOMR for this Project, Case No. 01-09-589 approved October 26, 2001 has been superseded by the LOMR cited above. The purpose of this CLOMR is to document the affects of the proposed developments and improvements on effective floodplains located at Damonte Ranch Phase V and Bella Vista Ranch Phase 1. Portions of these improvements were contained in the original CLOMR. Only panels 3186 and 3187 are being modified in this CLOMR.

A number of hydrology and hydraulic analysis reports are available for this area and the surrounding development. These reports are listed in the reference section.

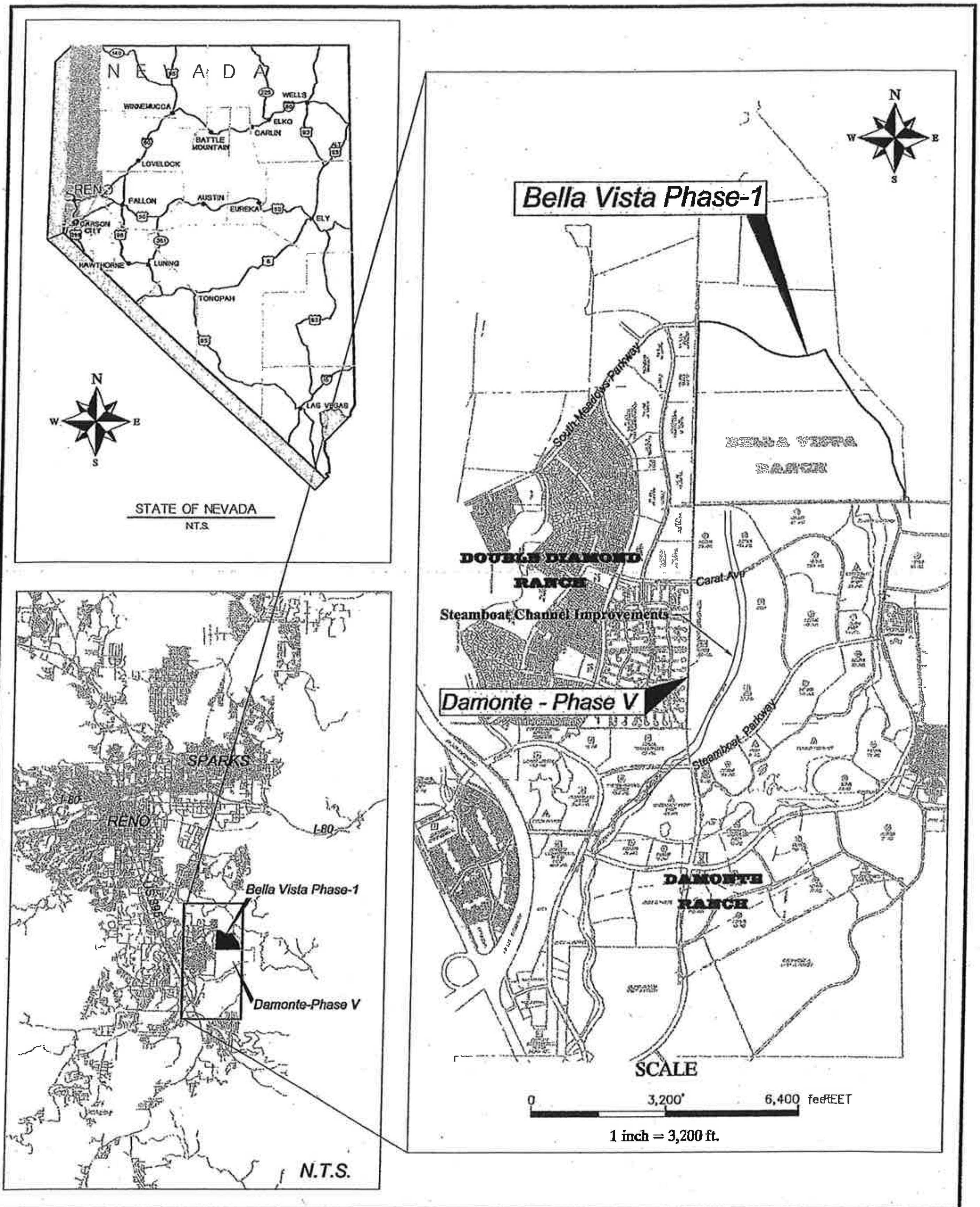


Figure 1

Vicinity Map

Damonte - Phase V and Bella Vista Ranch - Phase 1

Centex Homes

Quad Knopf Job #: N0432
File:\0432_Fig1_Vicinity.dwg

Date: February, 2006

Quad Knopf
9600 Prototype Ct.
Reno, Nevada 89521
TEL: (775) 324-1212
FAX: (775) 324-2311
WEB: www.quadknopf.com
N0432

2.0 EXISTING AND PROPOSED CONDITIONS

2.1 Existing Conditions

As mentioned earlier, the most recent floodplain adjustments (Figure 2) were done under Damonte Ranch/Double Diamond Ranch Regional Flood Control Improvements (FEMA Case No. 05-09-0105P). Steamboat Creek high flows will be split at the Damonte Diversion Structure. Approximately 4154 cfs (52% of the 100-year flood flow) will continue northward in the existing Steamboat Creek channel, and 3838 cfs (48% of the flow) will be diverted eastward through regional detention basin, wetlands and ponds, then northward to the Damonte Ranch property line. Flows will be returned to sheet flow conditions prior to reaching the Bella Vista Ranch in order to maintain existing flow conditions on the Bella Vista Ranch (watershed D5 in Figure 4).

It should be noted that 100-year flood flows mentioned here are corrected so as to be consistent with the result of the HEC-1 model attached in the recent LOMR (Nimbus Engineers, 2004).

2.2 Proposed Conditions

Damonte Ranch

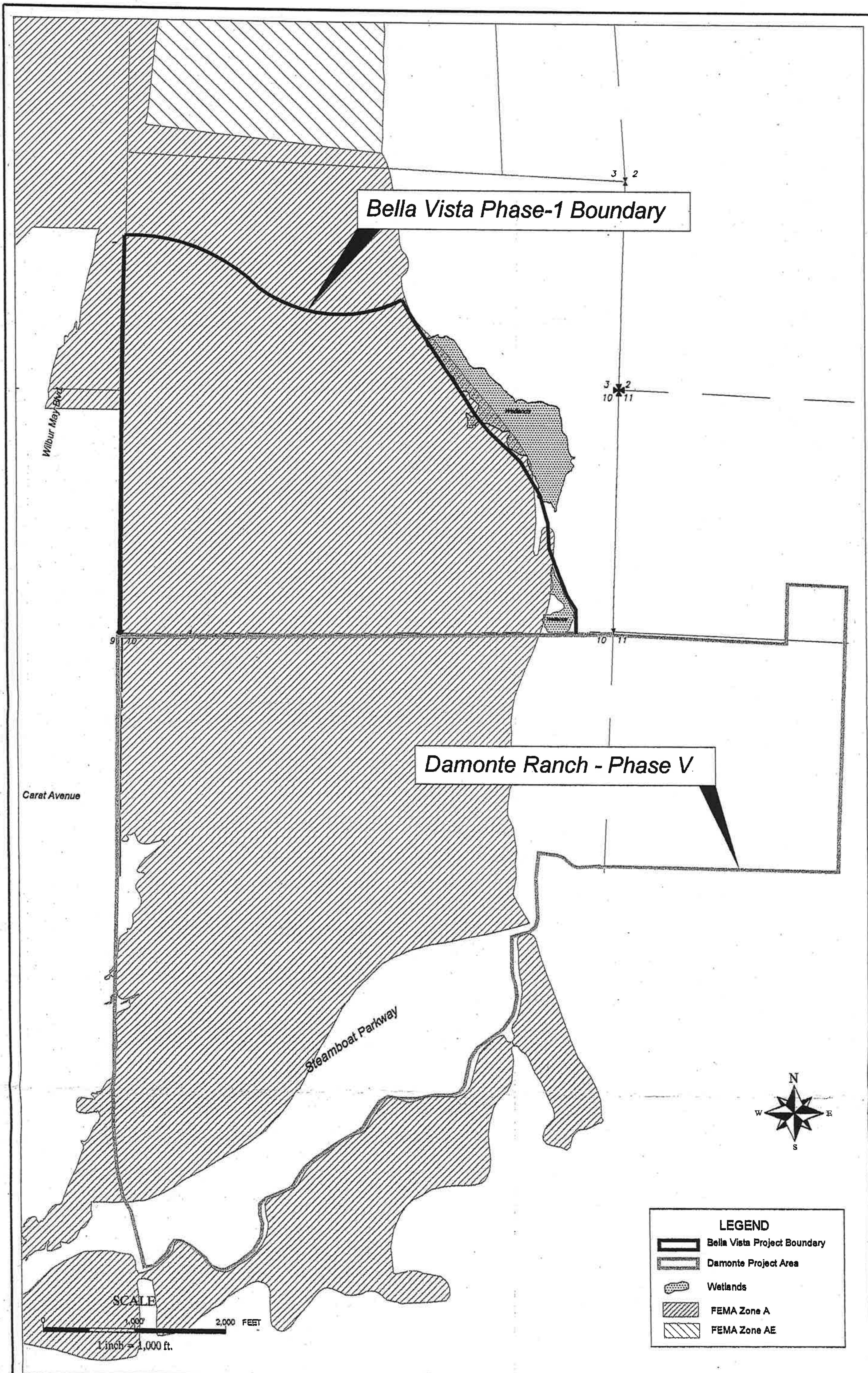
The proposed Phase V of Damonte Ranch is located north of the new flood control detention facilities on Damonte Ranch and south of the Bella Vista Ranch (Figure 1). Damonte Ranch is a medium- to high-density single family residential development with lot sizes generally less than 1/8 acre. There will be an improvement in the Steamboat Creek. New channels will be constructed to convey the storm waters from the Damonte Ranch Phase V development to the nearby wetland area, the improved Steamboat Channel and the Bella Vista property.

Bella Vista Ranch

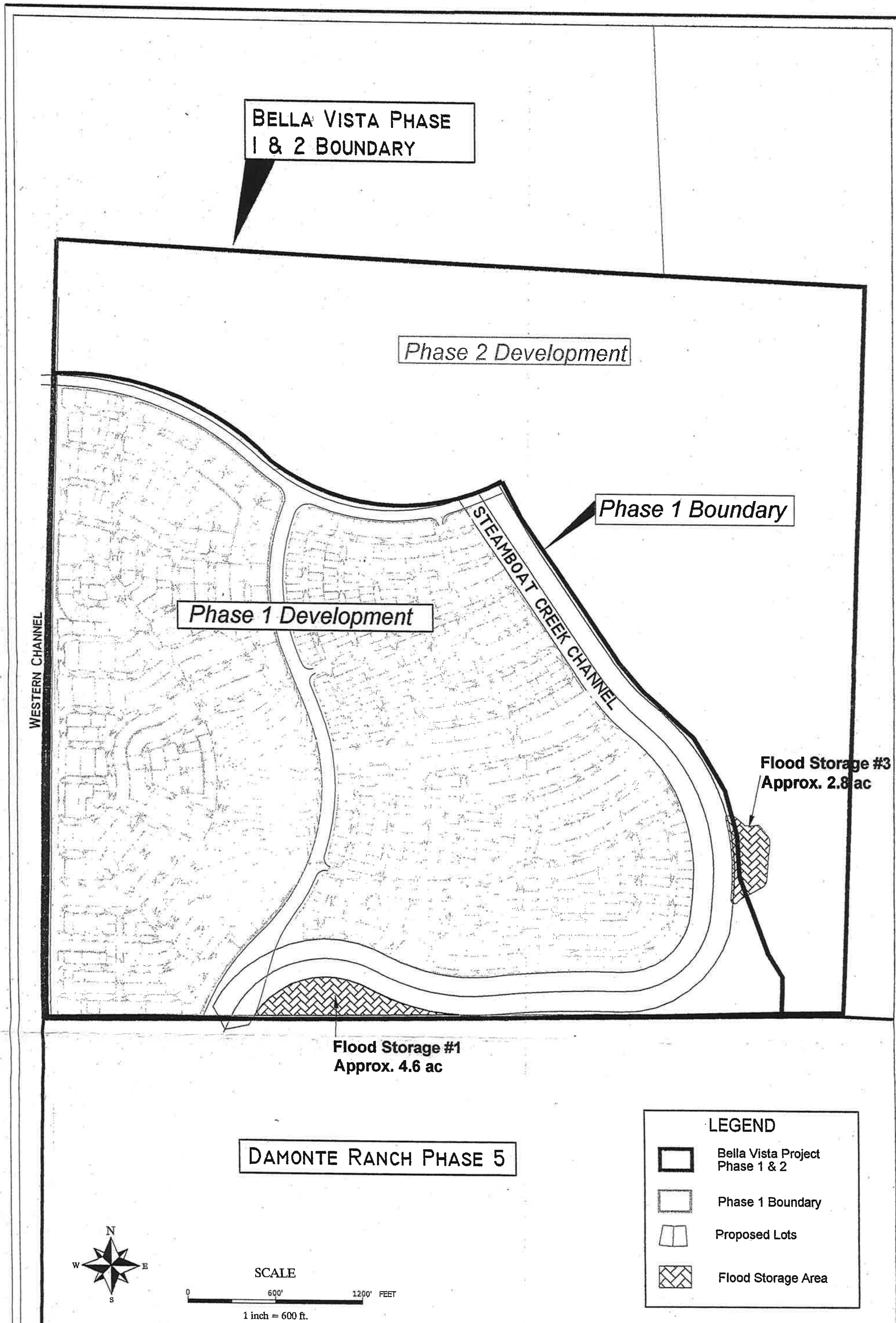
The proposed Bella Vista Ranch development is located in sections 3 and 10, T 18 N, R 20 E (See Figure 1). The majority of the Bella Vista Ranch lies within a broad alluvial valley in the southern portion of the Truckee Meadows. A small portion of the property on the easterly boundary is situated on the lower portion of the Virginia Range. Properties to the south, the Damonte Ranch, and the west, the Double Diamond Ranch, are undergoing intensive master planned development. The Bella Vista development will be constructed in two phases1 and 2 (Figure 3).

The proposed condition for this CLOMR will include construction of a channel for Steamboat Creek which will collect flow from the Damonte Steamboat Creek channel near the southwest corner of the Bella Vista property, turn eastward and then largely follow the historic Steamboat Creek channel along the eastern side of the property. The channel is designed to collect the storm waters from the Damonte Ranch development and from the Virginia Range adjacent to the property. The East-West Channel and the West Channel, small channels to convey local drainage, will be constructed to convey onsite runoff from portions of Phase 1 to the Steamboat Channel.

Detention facilities are not required for this development because there was no increase in the peak runoff for the 100-year storm due to development. However the City of Reno does require that increase in volume due to development in a 100-year 72-hour storm to be stored onsite for a period of 72 hours. Two storage basins No. 1 and No. 3 will be constructed to mitigate impacts on runoff volumes due to development (see Figure 3).



Sheet 1 of 1 Quad Knopf Job # N0432	**FIGURE 2** Existing Conditions FEMA Zone Map Damonte - Phase V and Bella Vista Ranch - Phase 1 Centex Homes	Scale: 1" = 1,000' CI: detailed contours = NA File Name: 0432_Fig2_&_Firm-Figs.dwg Drawn By: GH	Revisions:	Quad Knopf 9800 Prototype Ct. Reno, Nevada 89521 TEL: (775) 324-1212 FAX: (775) 324-2311 WEB: www.quadknopf.com N0432



Sheet 1 of 1	FIGURE 3	Scale: 1" = 600'	Revisions:	9600 Prototype Ct. Reno, Nevada 89521 TEL: (775) 324-1212 FAX: (775) 324-2311
Quad Knopf Job: N0432	Phasing and Flood Storage Areas Bella Vista - Phase 1	Ci: NA		
		File Name: 0432_Fig3,6,7.dwg		

3.0 HYDROLOGIC ANALYSIS

The hydrologic analyses for Damonte Phase V and Bella Vista Phase 1 projects have been performed using the Corps of Engineers HEC 1 computer program and current effective models accepted by FEMA. The analyses enclosed are as existing condition (sheet flooding from the south; file name 0243AB.dat) and as developed conditions (Damonte Ranch Phase V; file name DRph5.dat, and Bella Vista Phase 1; DRph5+BV1.dat).

The hydrologic work maps (Figure 4) display the basin configuration used in the models. Refer Nimbus Engineers (2004) for watershed parameter used in the models. The key point of comparison for pre- and post-development conditions is the model point PT04, which is the downstream terminus of the model (at the Huffaker Narrows). This point will be used to compare the impacts of the project on peak runoff rates and total runoff volumes. The following table includes descriptions of the models and their file names. These models are included in electronic form on a CD in Appendix C.

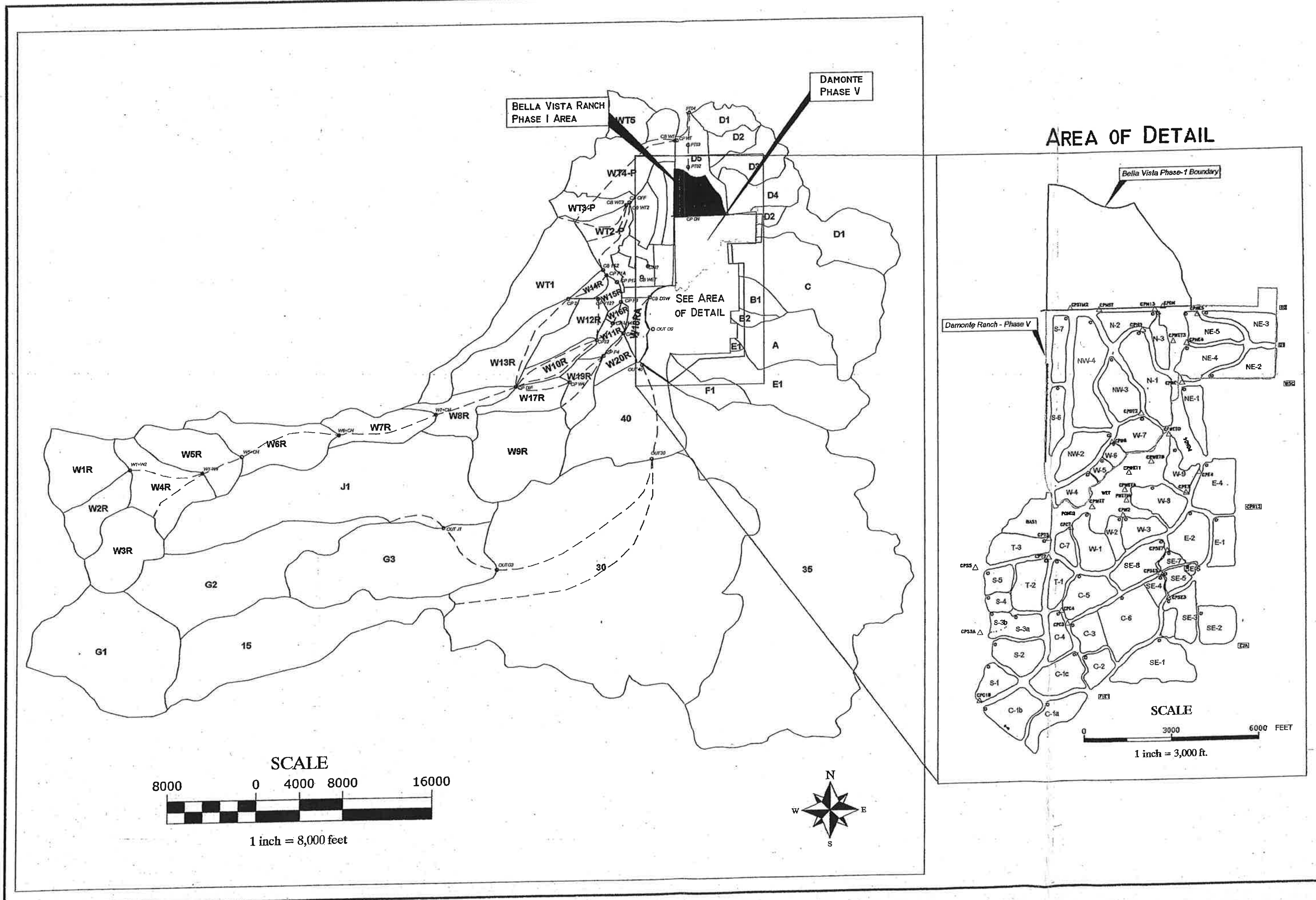
Table 1 HEC-1 Models Summary

Regional Models		Peak flow
0243AB.dat	-Existing Conditions	6362
DRph5.dat	- Existing conditions w/ Damonte V	7165
DRph5+BV1.dat	-Post-development (through Phase 1)	7022

Onsite 100-year 72 hour Models:		Volume
BV72UND.dat	-Existing conditions	101 ac-ft
BV72DEV1.dat	-Post-development (through Phase1)	121 ac-ft

When the outflow hydrographs are combined, the peak flow rate is 7022 cfs, the flow rate at the Huffaker Narrows for post-development conditions. This is smaller that that of the existing condition (7165 cfs) since the combined flow from Bella Vista area reach to its peak faster than the off-site watersheds.

The pre-development 100-year 72-hour model showed a volume of 101 acre-feet generated on the project site. The post-development model showed a volume of 121 acre-feet, an increase of 20 acre-foot from Bella Vista Phase 1 project.



Quad Knopf
9600 Prototype Court
Reno, Nevada 89521
TEL: (775) 324-1212
FAX: (775) 324-2311
WEB: www.quadknopf.com

References:

Scale: 1" = 8000' & 1" = 3000' (inset)
Contour Interval: NA
File: 0432_Fig4_Reg-Sheds.dwg
Drawn By: GH

FIGURE 4
REGIONAL WATERSHED MAP
Bella Vista Phase 1 & Damonte Phase V

Sheet 1 of 1
Quad Knopf Job #
N0432

3.1 On-site Hydrologic Analysis

3.1.1 Damonte Ranch Phase V

The SCS methods were originally used to develop the on-site parameters used in the HEC-1 (U.S. Army Corps of Engineers, 1998) hydrologic modeling for the Southeast Truckee Meadows. Due to revisions in the grading plan and lot layouts, the number of watersheds has increased from the original Southeast Truckee Meadows study and the watershed boundaries were modified in this study. The overall drainage patterns were not significantly altered. Figure 4 shows the original watershed map for the region and Figure 5 shows the revised on-site watersheds used in the new post-development HEC-1 model.

Curve numbers originally developed for this area as a part of the Southeast Truckee Meadows Flood Control Master Plan were modified as needed based on development type (see the calculations for original curve numbers in Nimbus Engineers, 2004). The new curve numbers for Damonte Ranch Phase V were determined based upon the criteria in Table 702 of the Washoe County, Hydrologic Criteria and Drainage Design Manual (Washoe County, 1996). Developed conditions used to estimate curve numbers were 1/8 and ¼ acre lots, neighborhood areas, and wetlands. Table 2 shows the hydrologic parameters in the revised HEC-1 model. Supporting calculations are shown in Appendix B. The HEC-1 model (File name DRPH5.dat) is presented in Appendix C.

Table 2. Onsite Watershed Parameters: Damonte Phase V.			
Watershed	Area, square miles	Curve Number	Lag Time, hours
A1	0.014	90	0.289
A2	0.02	90	0.167
A3	0.005	90	0.167
A4	0.017	90	0.197
A5	0.047	83	0.313
A6	0.019	90	0.289
A7	0.037	85	0.531
A8	0.071	88	0.338
A9	0.05	83	0.286
A10	0.012	89	0.206
A11	0.014	90	0.275
A12	0.02	90	0.275
A13	0.045	83	0.295
A14	0.055	83	0.295
A15	0.018	87	0.308
A16	0.018	90	0.222
A17	0.029	83	0.235
A18	0.036	83	0.319
A19	0.036	83	0.269
A20	0.023	85	0.355
A21	0.015	93	0.212
A22	0.004	98	0.531
A23	0.004	98	0.531
NE2345	0.232	65+35% impervious	0.52
D12&13	0.057	84	0.312
X12+13	0.076	86	0.733
APTS-9	0.032	87	0.279

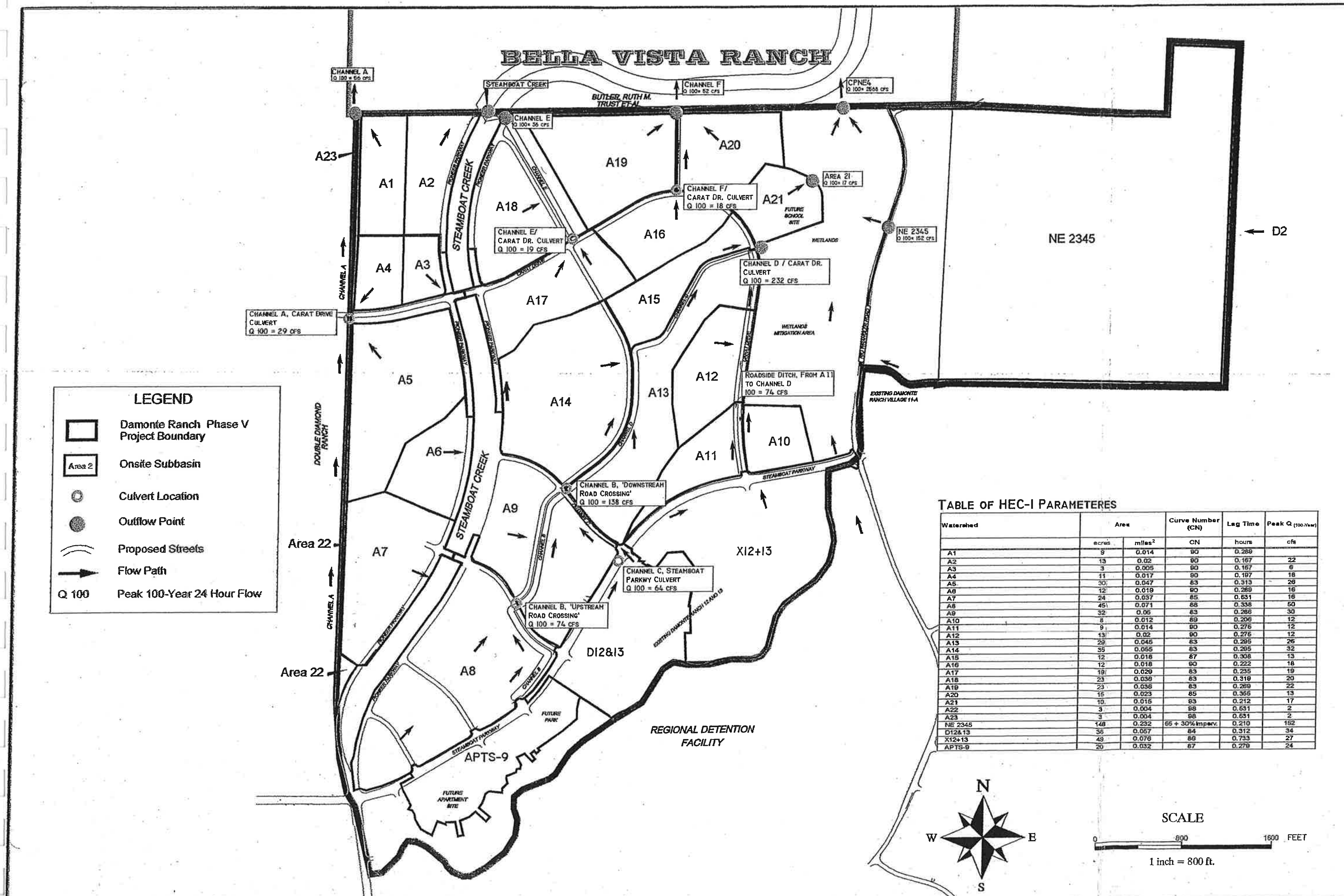


TABLE OF HEC-I PARAMETERES

Watershed	Area		Curve Number (CN)	Lag Time	Peak Q (100-Year)
	acres	miles^2	CN	hours	cfs
A1	9	0.014	90	0.289	
A2	13	0.02	90	0.167	22
A3	3	0.005	90	0.167	6
A4	11	0.017	90	0.197	18
A5	30	0.047	83	0.313	26
A6	12	0.019	90	0.289	16
A7	24	0.037	85	0.531	16
A8	45	0.071	88	0.338	50
A9	32	0.05	83	0.286	30
A10	8	0.012	89	0.206	12
A11	9	0.014	90	0.276	12
A12	13	0.02	90	0.276	12
A13	29	0.045	83	0.295	26
A14	35	0.055	83	0.295	32
A15	12	0.018	87	0.308	13
A16	12	0.018	90	0.222	18
A17	19	0.029	83	0.235	19
A18	23	0.036	83	0.319	20
A19	23	0.036	83	0.269	22
A20	15	0.023	85	0.356	13
A21	10	0.016	83	0.212	17
A22	3	0.004	98	0.531	2
A23	3	0.004	98	0.531	2
NE 2345	148	0.232	65 + 30% Imperv.	0.210	152
D12&13	36	0.057	84	0.312	34
X12+13	49	0.076	86	0.733	27
APTS-9	20	0.032	87	0.279	24

Quad Knopf
9600 Prototype Ct.
Reno, Nevada 89521
TEL: (775) 324-4212
FAX: (775) 324-2311
WEB: www.quadknopf.com
N0432

Revisions:

Scale: 1" = 800'
CI: 1 foot
File Name: 0432_Fig5_Dam5-Post.dwg
Drawn By: GH
Designed By: DW

FIGURE 5
Hydraulic Workmap
Onsite Proposed Conditions
Damonte Ranch Phase V
Reno, Nevada

Sheet 1 of 1
Quad Knopf Job: N0432
Date: Feb, 2006

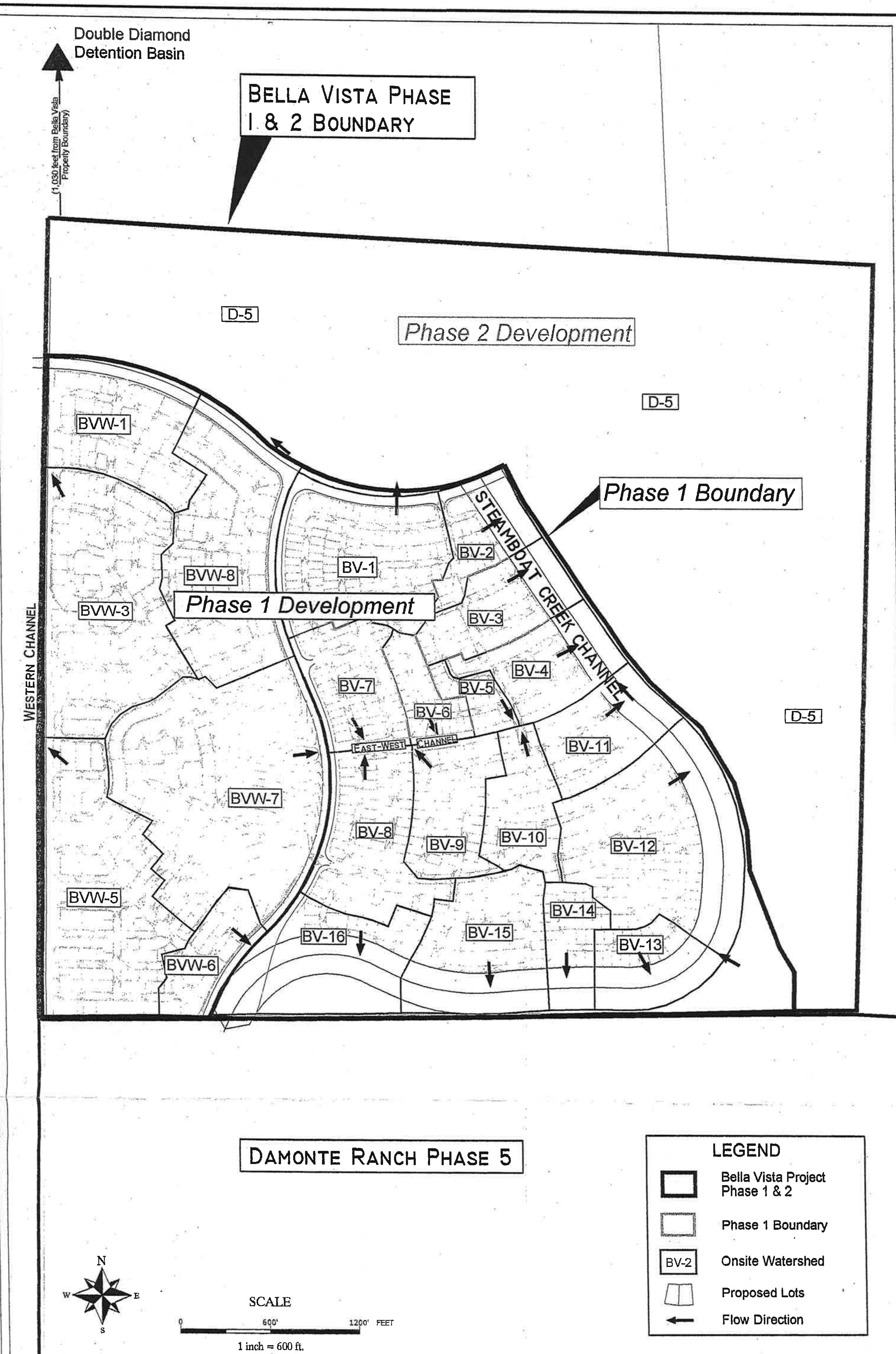
3.1.2 Bella Vista Ranch Phase 1

The Bella Vista Ranch on site flows will increase with the type of development planned. The impact of the increased on-site flows has been assessed using street patterns and site grading plans developed by Places Consulting. Most of those on-site flows will be directed to the restored Steamboat Channel, with lesser amounts being directed to the westerly boundary to the Double Diamond channel which was constructed to contain the sheet flows which formerly inundated the south eastern part of Double Diamond. Figures 6,5, and 7 show the project layout and the sub-watersheds used in the on-site analysis, the configuration of the Damonte V project used in this analysis and the soils map used to develop the curve numbers for the analysis. The on site hydrologic analysis was performed using the Corps of Engineers HEC-1 computer program. Rainfall Depth and Distribution was taken from the Southeast Truckee Meadows Flood Control Master Plan prepared by Nimbus Engineers. That report used NOAA Atlas 2 (U.S. Dept. of Commerce, 1973) for rainfall data. The rainfall depth for the 100-year, 24-hour event is 2.4 inches on the Bella Vista property. As in previous reports, the Type U.S. Soil Conservation Service Type II rainfall distribution was used.

On-site basins generally drain to the relocated Steamboat channel and the west side channel. The East-West channel will collect a portion of the flows from the future development on the western side of Steamboat Parkway (BVW-7) and from BV-5, BV-6, BV-7, BV-8, BV-9 and BV-10. Table 3 sets forth the parameters which were used in the HEC-1 model; times of concentration were determined to be the minimum (10 minutes) based upon the formulas in the Hydrologic Criteria and Drainage Design Manual, therefore they are not listed.

Table 3 On-site Watershed Parameters

Sub-basin ID	Area (acres)	Area (mi^2)	CN Pre-Development	CN Post-Development
BV 1	19.67	0.031	74	90
BV 2	4.50	0.007	74	83
BV 3	7.88	0.012	74	90
BV 4	7.66	0.012	74	90
BV 5	3.38	0.005	74	83
BV 6	5.44	0.009	74	90
BV 7	10.25	0.016	74	90
BV 8	14.94	0.023	74	83
BV 9	11.36	0.018	74	83
BV 10	9.43	0.015	74	83
BV 11	7.66	0.012	74	84
BV 12	19.68	0.031	74	85
BV 13	3.47	0.005	74	87
BV 14	4.69	0.007	74	84
BV 15	11.30	0.018	74	83
BV 16	3.74	0.006	74	83
BVW 1	14.15	0.0271	74	81
BVW 3	18.60	0.0501	74	79
BVW 5	14.04	0.049	74	90
BVW 6	6.50	0.010	74	83
BVW 7	39.83	0.062	74	83
BVW 8	24.13	0.0431	74	83



Sheet 1 of 1 Quad Knopf Job: N0432	FIGURE 6 Onsite Hydrologic Workmap Bella Vista - Phase 1	Scale: 1" = 600' CI: NA File Name: 0432_Fig3,6,7.dwg Drawn By: GH	Revisions:	Quad Knopf 9600 Prototype Ct. Reno, Nevada 89521 TEL: (775) 324-1212 FAX: (775) 324-2311 WEB: www.quadknopf.com

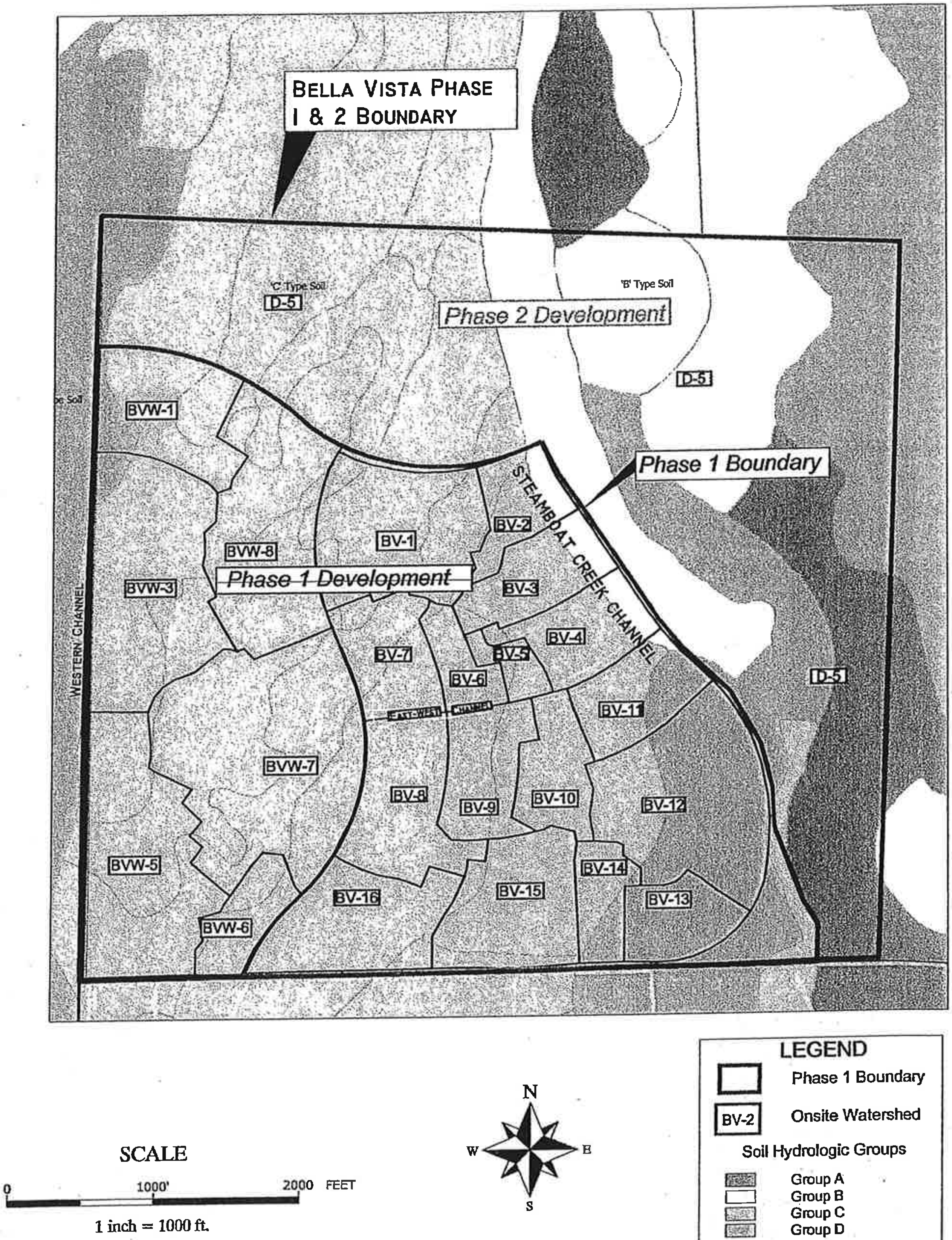


Figure 7
Soils Map
Bella Vista - Phase 1

Centex Homes

Quad Knopf Job #0432
File: 0432_fig3,6,7.dwg

Date: Feb. 2006

Quad Knopf
9600 Prototype Ct.
Reno, Nevada 89521
TEL: (775) 324-1212
FAX: (775) 324-2311
WEB: www.quadknopf.com

N0432

3.2 Results

The 100-year, 24 hour peak discharges at key locations (at key control points) are summarized in Table 4. Appendix C contains the hardcopy of the input and output for the HEC-1. The flow leaves the Phase V development at four points; namely, the Western Perimeter Ditch, the Steamboat channel, the F channel, and the wetland area north of Pond 4. The peak flows in the Main Steamboat channel are within the acceptable limits (see Section 4.0).

Table 4 100-year, 24 hour Peak Discharges at Key Locations, Damonte Ranch Phase V and Bella Vista Ranch Phase 1

100-Year Flow Rates at the Main Steamboat Channel in Damonte Ranch Phase V, cfs		
Location	Model Node	Flow Rate
Main Steamboat Channel, at entrance	OUTDM	4150
Main Steamboat Channel, after onsite sub basin 7	STM+7	4158
Main Steamboat Channel, after onsite sub basin 6	STM+6	4166
Main Steamboat Channel, after onsite sub basin 3	STM+3	4170
Main Steamboat Channel, after onsite sub basin 2	STM+2	4177
Main Steamboat Channel, at exit	STM+E	4193
Western Perimeter Ditch	CHNL-A	57
Channel F	CHNL-F	51
Wetlands	DMNTE	2687
100-Year Flow Rates at the Main Steamboat Channel in Bella Vista, cfs		
At the entrance	STM+E	4193
East corner	StmBV3	6291
Immediately after the East-West Channel	StmBV2	6340
North end of Phase 1	StmBV1	6365

4.0 HYDRAULIC ANALYSIS

4.1 Existing Conditions

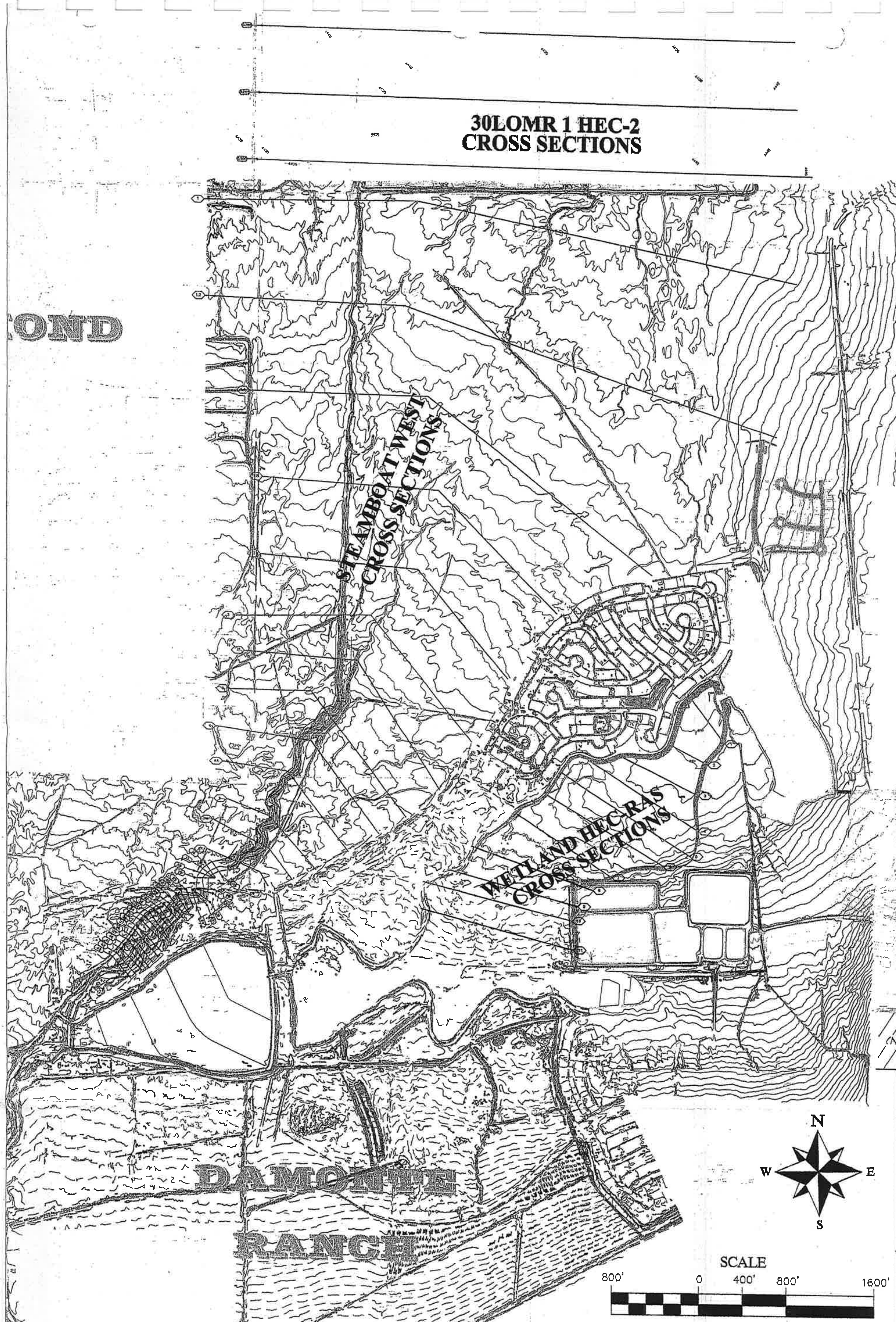
A series of detention/flow retarding basins were constructed for the Damonte Ranch flood control improvements. These improvements are designed to preserve and/or enhance existing wetlands and mitigate the effects of channelization and development on the Damonte Ranch site. The improvements and the resulting change in flow pattern were approved by a LOMR (Nimbus Engineers, 2004). This LOMR was approved by FEMA in October 2005. The post development condition for the LOMR is considered as existing condition for this CLOMR, which is summarized below.

Just downstream of the point where Branch 3 enters Steamboat Creek, the flow enters a diversion structure that directs approximately 52% of the 100-year peak flood flows (4154 cfs) northward in the Steamboat Creek low-flow channel, and the remaining 48%, approximately 3838 cfs, of the flow is diverted eastward through the Regional Detention Basin, Wetlands Detention, and Pond 4, and then northward to the Damonte Ranch property line (see Figures 8 and 9). The flows from both the Steamboat Creek channel and the flood control structures on Damonte Ranch are dispersed into sheet flow before entering the Bella Vista Ranch north of the Damonte Ranch property line. Table 5 summarizes the HEC-2/ HEC-RAS hydraulic models developed for the movement of the channelized flows from both the Steamboat Creek channel and the regional flood control structures to the Bella Vista Ranch (see Nimbus Engineers, 2004). It must be noted that all the elevations in the LOMR are referenced to older North American Geodetic Vertical Datum 1929 (NGVD29).

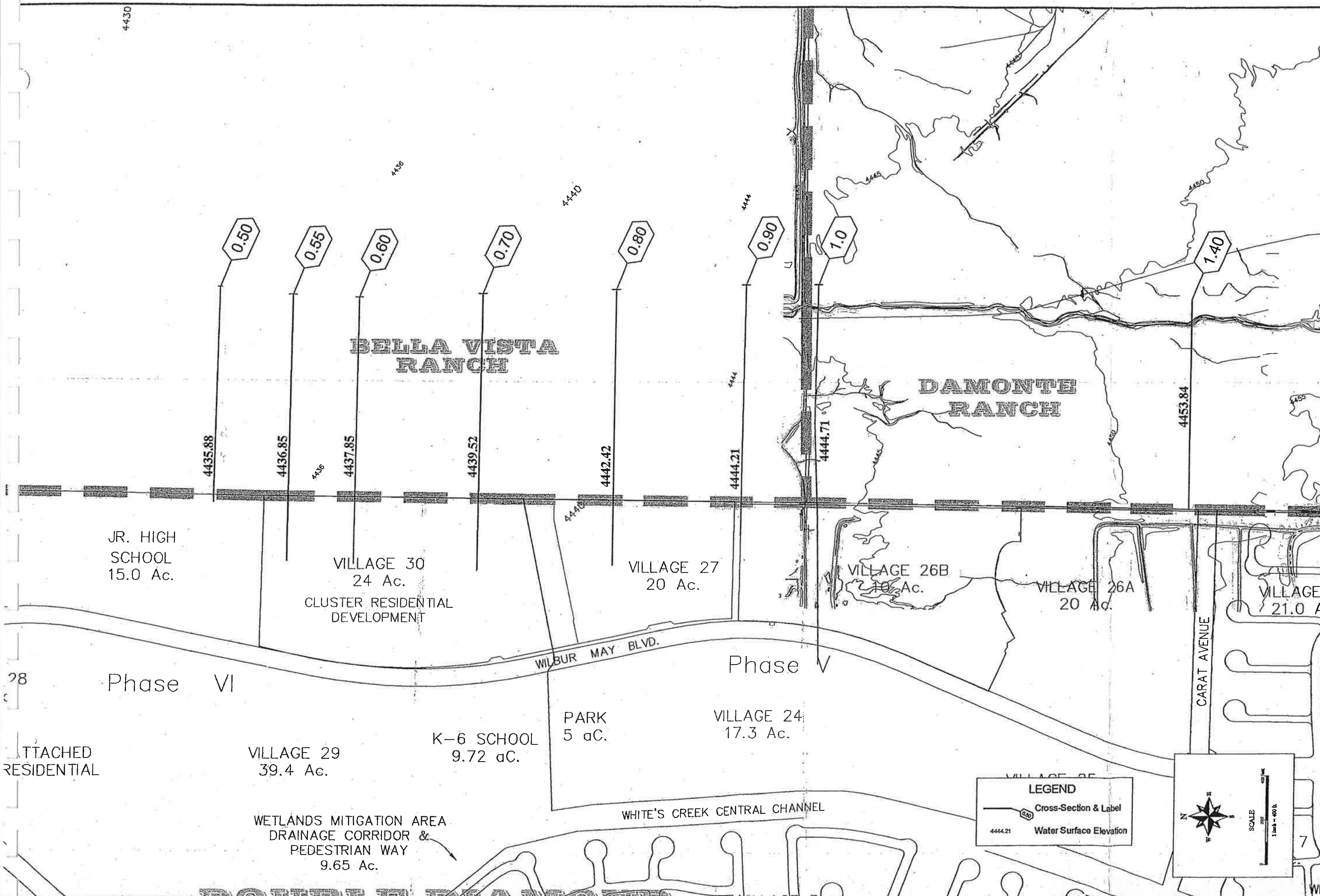
Table 5: Damonte Ranch Flood Control Facilities Models (Nimbus Engineers, 2004)

HEC-2 or HEC-RAS Input File Name	Hydraulic Model Description
30LOMR1.DAT*	Sheet flow across the Bella Vista Ranch
DDVIL30.DAT*	Flow spilling westward out of Steamboat Creek
Wetld.prj	Sheet flow across Wetlands
243EAST1.DAT	Detention basin flow to Bella Vista Ranch - Channelized flow to sheet flow
243WEST.PRJ	Steamboat Creek channel flow to Bella Vista Ranch - Channelized flow to sheet flow

* HEC-2 models, all others are HEC-RAS



Sheet 1 of 1	FIGURE 8 Existing Conditions 100-YR Hydraulic Workmap	Scale: 1" = 800'	Revisions:
Quad Knopf Job: N0432	Reno — Centex Homes — Nevada	CI: 1 foot File Name: 0432_Hydraulic-Wkmap-0243lomr	Quad Knopf 9600 Prototype Ct. Reno, Nevada 89521 TEL: (775) 324-1212 FAX: (775) 324-2311 WEB: www.quadknopf.com N0432
Date: Feb, 2006		Drawn By: GH Designed By: DW	



Quad Knopf
9600 Prototype Ct.
Reno, Nevada 89521
TEL: (775) 324-1212
FAX: (775) 324-2311
WEB: www.quadknopf.com
N0432

Revisions:

Scale: 1" = 400'
CI: 1 foot
File Name:
Drawn By: GH
Designed By: DW

FIGURE 9
EXISTING CONDITION HYDRAULIC WORKMAP
DDVIL3A.DAT CROSS SECTIONS
STEAMBOAT LEFT SPILL
Centex Homes
Reno Nevada

Sheet 1 of 1
Quad Knopf Job: N0432
Date: Feb, 2006

4.2 Proposed Conditions

Hydraulic calculations for the proposed Steamboat channel were performed with HEC-RAS version 3.1.3 using the peak flows generated with the HEC-1, developed condition model described in the Hydrologic Analysis section of this report. The Hydraulic Work Maps (see Figure 10 and Figure 11) show the alignment of the proposed Steamboat Channel and the location of the HEC-RAS sections along the channel alignment. Standard Table No. 1 and 2 of the HEC-RAS calculations and HEC-RAS cross sections of the proposed channel are contained in Appendix D. Plan and Profile Drawings for the proposed Steamboat channel are enclosed in Appendix E.

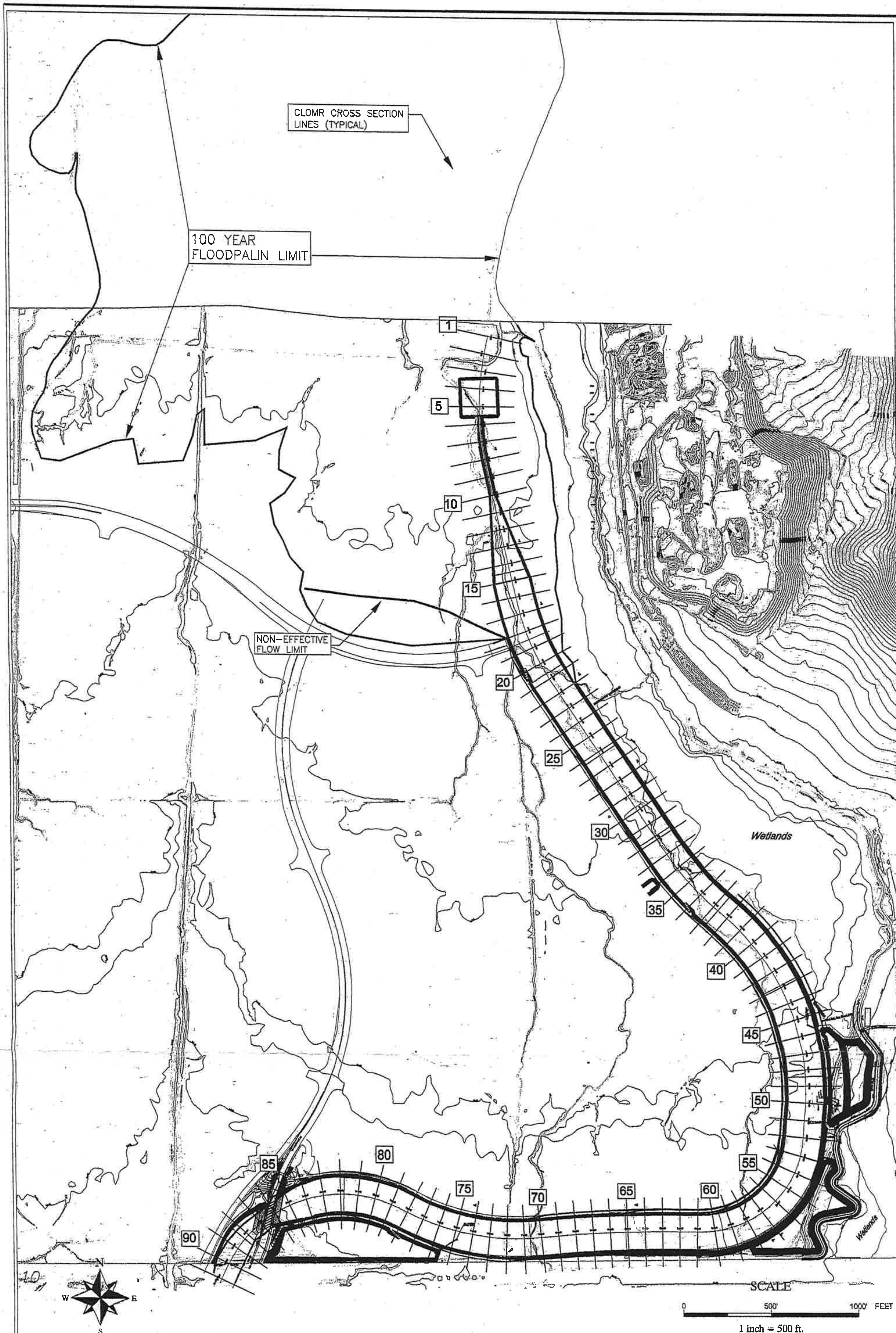
4.2.1 Steamboat Channel: Damonte Reach

At the Damonte Diversion Structure, flows up to 3500 cfs flow northward to Phase V. This will be called West Steamboat in this discussion. Flows exceeding 3500 cfs are divided between the branch continuing northward and a branch diverted eastward through detention basins and wetlands before turning northward to Phase V. As mentioned earlier the 100 year flow of 7992 cfs is about evenly divided with 52% (4154 cfs) continuing northward down to Phase V and 48% (3838 cfs) diverted eastward over the weir. A channel has been designed for the West Branch and a HEC-RAS model has been run on it (see Damonte.prj). The channel geometrics were taken from the proposed grading plan for Damonte Subdivision, which is based on NGVD29. It is proposed with 1:6 rockery sidewalls and a 150-foot wide undulating bottom with proposed rocks and boulders placed in the channel, therefore a Manning's n-value of 0.045 was used for this reach. The channel slope is 0.003 ft/ft. A known water surface elevation from the Bella Vista reach (see below) was used as downstream control for Damonte reach. Since all elevations in Bella Vista reach are referenced to the North American Datum Vertical Datum 1988 (NAVD88), the downstream control elevation for Damonte reach was adjusted to NGVD29 by subtracting 3.33ft.

The channel was designed to provide one foot of freeboard during the 100-year event. Velocities were typically 5 to 6 ft/sec, with isolated values higher.

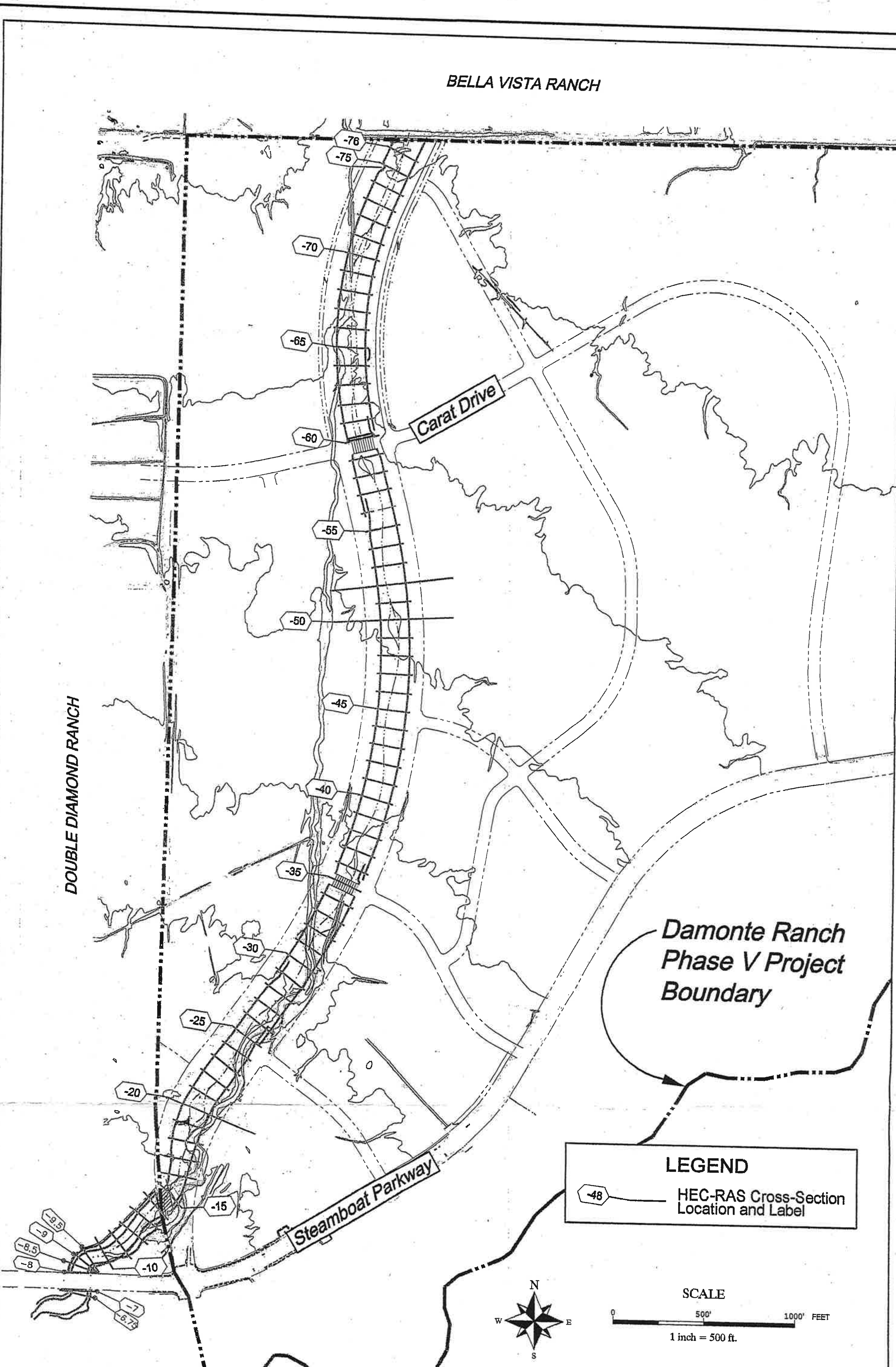
Culvert

Road crossings consisted of two concrete box culverts. At the upstream crossing, there is a 7-barrel 12-foot wide reinforced concrete box culvert, six of the barrels are 6-foot high and the remaining barrel is 8-foot high to accommodate the low flow channel. The culvert barrels are parallel to direction of flow and skewed to the roadway alignment. Under Carat Drive, there are 8-12 foot wide by 8 foot high barrels and one 12 foot wide by 10 foot high barrel. Riprap is installed at the culvert outlets for channel protection.



Sheet 1 of 1	FIGURE 10	Scale: 1" = 500'	Revisions:
Quad Knopf Job: N0432	Proposed Condition Hydraulic Workmap Steamboat Channel Bella Vista - Phase 1	CI: 1 foot File Name: 0432_CONST-PLANS.dwg	

9600 Prototype Ct.
Reno, Nevada 89521
TEL: (775) 324-1212
FAX: (775) 324-2311
WEB: www.quadknopf.com



Sheet 1 of 1 Quad Knopf Job: N0432	FIGURE 11 Proposed Condition Hydraulic Workmap Steamboat Channel Damonte Ranch Phase V	Scale: 1" = 500' CI: 1 foot File Name: 0432_Fig9_Dam5-Post.dwg Drawn By: GH	Revisions:

Quad Knopf
9600 Prototype Ct.
Reno, Nevada 89521
TEL: (775) 324-1212
FAX: (775) 324-2311
WEB: www.quadknopf.com

4.2.2 Steamboat Channel: Bella Vista Reach

The channel that is proposed for Steamboat Creek is compatible with the goals of the Steamboat Creek restoration plan and has been developed in consultation with the U.S. Army Corps of Engineers and the wetland scientists for the project. The channel will convey the western flows to the east to combine with the flows from the Damonte wetlands and then continue to the north in the alignment of the historic Steamboat Creek channel. The Phase 1 portion of the channel slope varies from 0.0016 to 0.0018 ft/ft.

Upstream of Veterans Parkway the channel geometrics were taken from the proposed grading plan for Damonte Subdivision. The elevations of the cross sections were adjusted to NAVD88 by adding 3.33 because all topographic maps in Bella Vista Ranch Phase 1 project are referenced to NAVD88.

The channel between Veterans Parkway and South Meadows Parkway (River Station 84 through River Station 17) is a trapezoidal cross section with a 200-foot bottom and 3:1 side slopes. A meandering first flow channel having a capacity of about 70 cfs will be constructed throughout this reach. Manning's n-values of 0.035 were assumed for the flat bottom and the sides of the channel and 0.030 for the meandering low flow channel for this reach of channel. The low flow channel will be constructed under the direction of the COE and the wetlands consultant. It must be noted that the size and shape of the low flow channel has been determined by a geomorphic study (see Myers Design Engineering, 2006).

From River Station 18 through River Station 48 the east bank of Steamboat Creek intercepts the existing ground at 3:1 slope. Storage basin No. 3 is constructed adjacent to the east bank from River Station 48 through River Station 51. From River Station 51 through River Station 54 the east bank intercepts existing ground at a 3:1 slope. Riprap is placed around the curve on the east and south banks from River Station 54 through River Station 60. The riprap protects the channel bank from erosion from the sheet flows entering Steamboat channel from the Damonte wetlands. From River Station 60 through River Station 76 the south bank intercepts existing ground at a 3:1 slope. Storage basin No. 1 is constructed adjacent to the south bank from River Station 76 westerly to the culvert under Veterans Parkway where the bank increases in height to meet culvert wing wall. The proposed development is in fill adjacent to west and north banks eliminating the need for a levee along these sides. The banks are 6 foot high with a 3:1 slope. A 12 foot wide combination trail and access road is constructed at the top of the 6 foot slope. The westerly bank increase in height as it approaches Veterans Parkway to meet the culvert wing walls.

Downstream of South Meadows Parkway the flow transitions to sheet flow before reaching the Bella Vista Phase 1 northern boundary (River Stations 5 through 17). The bottom of the channel transitions from 200 feet to 31 feet and the 3:1 side slopes intersect the existing ground on both sides of the channel allowing the flow to spill out into the natural floodplain. The divergence angle from channel flow to sheet flow was controlled by the use of non effective flow areas along the westerly side to provide a theoretical smooth transition in width. A Manning's n-value of

0.035 was also used for this reach. The first flow channel transitions from 2 foot deep to the flow line of the existing channel at River Station 5.

It must be noted that a normal depth (corresponding to slope, $s=0.0022$) was used at section 0.1 for downstream control of the Bella Vista reach. Also sections and n-values are taken from the existing LOMR downstream of Section 4.

Culvert

A 9-barrel 12-foot wide reinforced concrete box culvert will be constructed under Veterans Parkway. Eight of the barrels are 6-foot high and the remaining barrel is 8-foot high to accommodate the low flow channel. The culvert barrels are parallel to direction of flow and skewed to the roadway alignment. Upstream the channel bottom transitions from the 150-foot width to the inside wall of the two outside barrels of the culvert. The 1:6 rockery walls intersect the culvert wing walls. Downstream the 200-foot bottom width channel transitions smoothly to the inside wall of the exterior culvert barrels. The 3:1 side slopes parallel the edge of the bottom transition ending at the culvert headwall. A concrete apron is placed upstream of the culvert for bottom control as the flow line of the channel drops into the culvert. Downstream of the culvert a grouted rock riprap apron is placed to dissipate the energy and control erosion at the culvert outlet. A NDOT standard reinforced concrete box culvert and wing walls will be constructed at the crossing. The end wall will be modified to accommodate the placement of pedestrian railing. Standard HEC-RAS culvert table is contained in Appendix D.

Storage Basins

Two storage basins (see Sheet C12 and Sheet C14 , Appendix E) will be constructed to contain the 20 acre-feet increase in volume of runoff due development as discussed in the Hydrology Section. These basins are designed to contain the volume removed from Steamboat Channel near the peak flow for a 100-year design storm. The total capacity of the two basins is 24.56 acre-feet with a net retained volume of 20.63 acre-feet at a 72-hour duration from beginning of storm. See discussion under Outlet Structures. Volumes were calculated by measuring the areas at elevation increments and calculating a volume vs depth curve for each basin. Supporting calculations are included in Appendix D.

Lateral Weirs

The lateral weirs discharging into the basins from Steamboat Creek are designed to pass more than the desired volume to be stored and control the amount stored by placing an overflow spillway on the edge of the basin that will discharge back into the main channel. This eliminates the problem of clipping an exact volume of flow from a natural channel. Both lateral weirs are constructed of a combination of riprap and concrete. The concrete forms the actual weir geometrics and the riprap protects the channel bank and basin bank below the weir.

Varying rates of flow were used for the channel and lateral weir to calculate a rating curve for channel flow vs weir flow. The lateral weir table from HEC-RAS is contained in Appendix D. Using the rating curve and the peak hydrograph a length of weir and weir elevation was set to pass approximately the volume required from the channel to the basins. Graphs of the computed flow to the basin vs total flow in Steamboat Creek are contained in Appendix D.

Outlet Structures

The outlet structure provided consists of a 12-inch RCP with a "Duck-bill" flap gate on the downstream end with a 3-inch orifice through a 2-foot concrete plug on the upstream end. The upstream end is enclosed in a 2-foot high vertical slotted 24-inch diameter CMP with a grate on top.

Calculations were done to estimate the volume of flow remaining in the basin after 72 hours. The calculations were done on a time step method utilizing the Steamboat Hydrograph. The calculations were performed using a excel spread sheet to calculate the amount of flow leaving the basin with a 3-inch acting as an orifice in the outlet structure. The depth of flow in Steamboat Channel will cause the pipe to remain in the exit control condition during the 72-hour time frame. The depth of flow in the channel during this 72-hour time period was determined by assuming normal depth in Steamboat Channel for the various flows calculation interval.

4.2.3 Results of Hydraulic Modeling

The annotated FIRM (Plate 2) shows the results of the hydraulic analyses. The proposed improved and relocated Steamboat channel will safely contain and convey the 100-year, 24-hour storm flow, and as a result a large section of the Damonte Ranch phase V and Bella Vista Ranch Phase 1 is removed from the existing FIRM (Zone A) flood plain (Plate 1). The revised floodplains are shown in the annotated FIRM (Plate 2) and on the Topographic Workmap (Figures 10 and 11).

5.0 CONCLUSIONS

The following conclusions are based upon the detailed hydrologic and hydraulic analyses contained in this CLOMR request for the Damonte Ranch phase V and Bell Vista Ranch Phase 1:

1) Detailed hydrologic and hydraulic analysis of the proposed conditions floodplain within the project study area shows that a large section of the Damonte Ranch phase V and Bella Vista Ranch Phase 1 may be removed from the existing FIRM (Zone A) flood plain.
2) Flow exiting the Bella Vista Ranch Phase 1 boundary is returned to its natural sheet-flow conditions.
3) The proposed improvement for Steamboat Channel in Damonte Phase V and the Bella Vista Ranch Project areas will safely contain and convey the 100-year, 24-hour storm flow. The revised floodplain is shown in the annotated FIRM (Plate 2) and on the Topographic Workmap (Figures 10 and 11).

6.0 REFERENCES

Myers Design Engineering, Fluvial Geomorphology Evaluation and Des[illegible] Bella Vista Ranch Reach on Steamboat Creek, Reno, Nevada, April 17, 2006

Nimbus Engineers, Application for Letter of Map Revision (LOMR): Damonte Ranch / Double Diamond Ranch Regional Flood Control Improvements, September 2004.

Nimbus Engineers, Application for Conditional Letter of Map Revision (CLOMR): Damonte Ranch / Double Diamond Ranch Regional Flood Control Improvements, March 2001, Addendum September 2001.

Nimbus Engineers, Application for Letter of Map Revision, Branch 3 of Whites Creek, Hydraulic Analysis of Branch 3, March 2001.

Quad Knopf, Bella Vista Phase 1 Hydrologic and Hydraulic Report, July 2005.

Quad Knopf, Flood Control Master Plan Bella Vista Ranch, May 2005.

Quad Knopf, Southeast Truckee Meadows Flood Control Master Plan Addendum Damonte Ranch Phase V, May 2005.

U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-1: Flood Hydrograph Package, Version 4.1, June 1998.

U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-RAS River Analysis System, Version 3.0.1, March 2001.

U.S. Department of Agriculture, Soil Conservation Service, Soil Survey of Washoe County, Nevada, South Part, August 1983.

U.S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Map, Verdi Quadrangle, Scale 1:24000, Contour Interval 20 Feet, 1994.

Washoe County, Hydrologic Criteria and Drainage Design Manual, Final Draft Report, December 2, 1996.

Geotechnical Memorandum

Black Eagle Consulting, Inc
1345 Capital Boulevard, Suite A
Reno, Nevada
Phone: 775 359-6600
Fax: 775 359-7766
Email: mail@blackeagleconsulting.com

Project No.: 0199-12-2

Project Name: Bella Vista Villages

To: Mr. Eric Gibbons, Centex Homes

From: Jonathan Pease, Ph.D., P.E.

Cc: Mr. Ralph Hogoboom, Quad Knopf

Date: November 29, 2006

RE: Channel Maintenance Road Recommendations

PROFESSIONAL ENGINEER STATE OF NEVADA
JONATHAN JOHNSTONE PEASE
Exp: 12 2007
CIVIL
No. 16296
11-29-06

This memorandum provides recommendations for the maintenance roads for the Steamboat Creek Channel through the Bella Vista Ranch subdivision. The maintenance roads will be constructed at the top of the Steamboat Creek bank, which will also be used for a bike path. Based on discussions with you, we understand that there will be seven access points to the creek channel which may be used for removing sediment in 10-wheeler dump trucks; the maintenance road will also be used for light trucks for trash removal and light maintenance. A large excavator (preferably trucked along the path on a low-boy trailer) and wheeled excavator may also be used for channel maintenance.

Based on discussions with you, heavy maintenance (sediment removal) would be expected to occur about twice a year. Assuming 10 truck loads per landing per maintenance visit, this would result in heavy truck traffic of about 140 heavy trucks per year. Assuming 1.4 equivalent 18-kip single axle loads (ESALs) per year, and assuming all truck traffic proceeds along the path in a single direction (on any given maintenance trip), the maintenance road would be subject to about 4,000 ESALs for a 20-year design life. This level of design loading is negligible compared to the maintenance performance of pavements with minimum design sections (e.g. 2-1/2 inches of asphalt concrete on 6 inches of aggregate base).

It is our recommendation that, with this large equipment, the main maintenance problems associated with this road would be (1) limiting operation of tracked equipment on any asphalt pavement which would score and break up the asphalt concrete, and (2) construction traffic will typically overlap the edges of the pavement, rutting the adjacent subgrade and cracking the pavement from its edges progressively. We therefore recommend designing the top of bank as an unpaved roadway with an appropriate width paved for pedestrian and bicycle traffic.

We recommend an unpaved roadway section, as wide as necessary, to consist of 6 inches of aggregate base compacted over 1 foot of pit run cobble-gravel soil. Pit-run soil would consist of clean rock material from the A&K west pit or equivalent, which would be 12-inch-minus, 1-inch-plus hard rocky material. These materials would be compacted as much as possible with heavy equipment, or until no further movement or deformation is noted. The aggregate base material would be placed on the pit-run material to provide a smooth driving course, with these materials compacted to 95 percent relative compaction. The edge of the gravel roadway section could be marked with plastic reflectorized stakes, which would also be visible when there is snow cover as well. This same roadway design can be used to provide a firm surface down the maintenance access ramps.

We recommend that the asphalt paved path can be constructed on top of the prepared gravel roadway surface. We recommend a minimum thickness of asphalt cement of 2-1/2 inches. The asphalt path should be routed as far inland from the top of ramps as possible, to allow maximum access to the maintenance ramps while minimizing tracking on the asphalt concrete.

END MEMO

JP/

Ralph Hogoboom

From: Jonathan Pease [jpease@blackeagleconsulting.com]
Sent: Wednesday, November 15, 2006 3:27 PM
To: Ralph Hogoboom
Subject: Correction/Suggestion Steamboat Creek culvert crossing

Mr. Hogoboom

In reviewing the details for the Steamboat Creek channel, we note the following:

Sheet D4, Detail 11/D4 shows the Veterans Culvert and the concrete apron upstream and downstream will be underlain by 2 feet of minus 4" pit-run gravel over geotextile. Based on our soils report and saturated conditions, we suggest 24 inches of 12- to 18-inch minus rock, overlain by a 4" or thinner layer of aggregate base (0 to 4" or as necessary to level the working surface) (no geotextile underneath). This should provide better support under the culvert apron, where equipment may be operated in the future, and avoids carefully placing the geotextile.

Please consider this detail

Thank you

Jonathan Pease

Black Eagle Consulting

1345 Capital Boulevard Suite A

Reno NV 89502

(775) 359-6600 phone

(775) 359-7766 fax

Black Eagle Consulting, Inc.
Geotechnical & Construction Services
1345 Capital Boulevard, Suite A
Reno, Nevada 89502-7140
Telephone: 775/359-6600
Facsimile: 775/359-7766
Email: mail@blackeagleconsulting.com

Mr. Shawn Harrison
Centex Homes of Nevada
10509 Professional Circle, Suite 200
Reno, Nevada 89521

November 15, 2006

Project No.: 0199-12-8

Re: Channel Bed Bearing Capacities
Bella Vista Ranch
Reno, Nevada

Dear Mr. Harrison:

This letter and attachments provide our design review confirming the bearing capacity available to support heavy equipment on the channel-bed stabilizing structures planned for the Steamboat Creek Channel. As requested by the City of Reno, the channel bed stabilizer should support a 90-ton trackhoe and box culvert aprons and the access between grade control structures should support a 12-ton loader and haul trucks.

Based on plans prepared by Quad Knopf stamped and dated September 29, 2006, the surfaces of the channel bed and grade control/maintenance structures will consist of a 6-inch-thick layer of 4-inch-minus rock fill, over 30-inch thick stabilizing rock fill conforming to the gradation requirements of Class 300 rip-rap, over bedding material, over a Mirafi 160N geotextile. The box culvert aprons will consist of a 12 inch thick PCC reinforced concrete slab, over a 2-feet-thick layer of 4-inch-minus rock, over a Mirafi 140N geotextile. Based on our observation of site conditions, approximately 2 feet of rock stabilizing fill will likely be required below the base of the 4-inch-minus rock.

Typical equipment weights, bearing area, and bearing pressures were calculated for the above-referenced equipment (Caterpillar, 2001) and are shown on Table 1. Bearing pressures are based on the uniform applied pressure at the ground surface, and also at 30 inches depth, the nominal depth of the bottom of the rip-rap or structural fill layer. The applied surface area for wheel loads is the equipment load per wheel divided by the tire pressure, assuming the ground will not also deflect under the wheel (which will typically also occur). We have assumed that the structural slab, rip-rap, and 4-inch-minus rock will spread equipment loads at depth, where the loaded area will increase by ½-foot-width per each 1 foot increase of depth, on each edge of the surface loaded area. For the track excavator, therefore, the applied bearing pressure at 2.5 feet depth (at the base of the rip-rap) will be about half of the track pressure at the ground surface.

TABLE 1- TYPICAL BEARING PRESSURES FOR HEAVY EQUIPMENT

Equipment	CAT Model	Weight	Track/Wheel Area	Bearing Pressure*
90-ton Trackhoe	CAT 375L	181,000 lb	2 x 20.8' x 2.5'	1750 psf at surface 840 psf at 30-inch depth
12-ton Loader	CAT 928G	25,000 lb	4 x 30 psi (0.5 ft radius under each tire)	7200 psf at surface 635 psf at 30-inch depth
Off-Road Truck	CAT 725	98,000 lb (full)	34% of load on rear axle, 2 x 45 psi (0.9 ft radius under each tire)	6500 psf at surface 1150 psf at 30-inch depth

Assuming relatively conservative friction angles and cohesion for sand or clay subgrade, we have calculated that the existing saturated subgrade soil will provide an allowable bearing capacity of 1,150 psf with a factor of safety of 2.5 or higher. Calculations are attached. We therefore recommend that the proposed aprons and other channel bottom structures will provide sufficient support for the proposed equipment loading and for the intended use.

If you have any questions, please feel free to contact us.

Sincerely,

Black Eagle Consulting, Inc.

Larry Johnson
President

PROFESSIONAL ENGINEER - STATE OF NEVADA
JONATHAN W. PEASE
Exp: 12-2007
CIVIL
No. 16296

11-15-06
Jonathan W. Pease, Ph.D., P.E.
Senior Engineer

JWP:LJJ:srf

Enclosure(s): Bearing Capacity Calculations

Copies to: Addressee (3 copies)

BLACK EAGLE CONSULTING, INC.
Geotechnical and Construction Services

Project Name: Bella Vista Steamboat Creek Channel
Project Number: 0199-12-8

Date: 10/23/2006
Revision Number: 0610
Developed By: JWP
Calculated By: JWP
Checked By:

CALCULATION OF 2002 AASHTO BEARING CAPACITY

Location: Wheel and Track Loads, Bella Vista CHannel
Foundation: Bearing Capacity Below 30" rip-rap layer -2 Cohesive

References

1. AASHTO, 2002, Standard Specifications for Highway Bridges, 17th Edition, American Association of State Highway and Transportation Officials.

Assumptions

1. Bearing capacity calculations account for foundation shape, possibility of local or punching shear, inclined load, eccentric loading, sloping ground, and ground water.
2. Calculations assume one, homogeneous soil unit.

Unit Conversions

Checked By:

$psf := \frac{lbf}{ft^2}$ $pcf := \frac{lbf}{ft^3}$ $kip := 1000lbf$ $ksf := \frac{kip}{ft^2}$ $kPa := 1000Pa$ $kN := 1000N$ $kJ := 1000J$

Input Data

Checked By:

Soil Cohesion:	$c := 1500psf$	$c = 71.8\,kPa$
Soil Friction Angle:	$\phi := 0deg$	
Total Soil Unit Weight:	$\gamma := 110pcf$	$\gamma = 17.3\,\frac{kN}{m^3}$
Depth of Foundation Base below Ground Surface:	$D_f := 2.5ft$	$D_f = 0.76\ m$
Depth of Ground Water from Ground Surface:	$GWT := 0ft$	$GWT = 0.00$
Foundation Width B (For Circular Footings B = L):	$B := 1ft$	$B = 0.30\ m$
Foundation Length L:	$L := 1ft$	$L = 0.30\ m$
Slope of Adjacent Ground:	$j := 0deg$	
Is Local or Punching Shear Possible (Yes = "Y" and No = "N")?	$F_{ps} :=$ "N"	
Axial Force on Footing (Vertical):	$Q := 6.2kip$	
Horizontal Force on Footing (Enter 0 for vertical load):	$P := 0kip$	$F = 0.0\,\frac{s^6 \cdot A^2}{kg^2 \cdot m^3}\,k$
Angle of Load Eccentricity (0 indicates F load is parallel to L axis, 90 B axis):	$\theta := 0deg$	
Moment in x-Dimension (Footing Width):	$M_x := 0kip \cdot ft$	$M_x = 0.0\,kJ$
Moment in y-Dimension (Footing Length):	$M_y := 0kip \cdot ft$	$M_y = 0.0\,kJ$
Adhesion Between Footing and Foundation Soil (Enter 0 for vertical load):	$c_a := 0psf$	$c_a = 0.0\,kPa$
Angle of Friction Between Footing and Foundation Soil (Enter 0 for vertical load):	$\delta := 0.8 \cdot \phi$	
Cohesionless Sloping Ground Bearing Capacity Factor:	$N_{\gamma q} := 0$	
Cohesive Sloping Ground Bearing Capacity Factor:	$N_{cq} := 0$	
Bearing Capacity Safety Factor:	$SF := 2.5$	

Calculate Reduced Shear Strength Parameters if Local or Punching Shear is Possible:

$$c := \begin{cases} 0.67 \cdot c & \text{if } F_{ps} = \text{"Y"} \\ c & \text{otherwise} \end{cases}$$ $c = 1500.0\,\text{psf}$ $c = 71.8\,\text{kPa}$

$$\phi := \begin{cases} \text{atan}(0.67 \cdot \tan(\phi)) & \text{if } F_{ps} = \text{"Y"} \\ \phi & \text{otherwise} \end{cases}$$ $\phi = 0\,\text{deg}$

Calculate Eccentricity in Footing "B" Direction:

$$e_B := \frac{M_y}{Q}$$ $e_B = 0.0\,\text{ft}$ $e_B = 0.00$

Calculate Eccentricity in Footing "L" Direction:

$$e_L := \frac{M_x}{Q}$$ $e_L = 0.0\,\text{ft}$ $e_L = 0.00$

Calculate Eccentric Loading Reduced Footing Dimensions:

$B' := B - 2 \cdot e_B$ $B' = 1.0\,\text{ft}$ $B' = 0.30\text{ m}$

$L' := L - 2 \cdot e_L$ $L' = 1.0\,\text{ft}$ $L' = 0.30\text{ m}$

Determine Effective Footing Dimensions based on any Eccentricity:

$$B' := \begin{cases} B' & \text{if } e_B > 0\text{ft} \\ B & \text{otherwise} \end{cases}$$ $B' = 1.0\,\text{ft}$ $B' = 0.30\text{ m}$

$$L' := \begin{cases} L' & \text{if } e_L > 0\text{ft} \\ L' & \text{otherwise} \end{cases}$$ $L' = 1.0\,\text{ft}$ $L' = 0.30\text{ m}$

Calculate the Eccentric Loading Effective Footing Area:

$A' := |B' \cdot L'|$ $A' = 1.0\,\text{ft}^2$ $A' = 0.09\text{ m}^2$

Calculate Buoyant (Saturated) Soil Unit Weight:

$\gamma_{sub} := \gamma - 62.4\text{pcf}$ $\gamma_{sub} = 47.6\,\text{pcf}$ $\gamma_{sub} = 7.5\,\frac{\text{kN}}{\text{m}^3}$

Calculate the Depth of Ground Water Below the Base of Foundation:

$z_w := GWT - D_f$ $z_w = -2.5\,\text{ft}$ $z_w = -0.76\text{ m}$

Calculate Eff Overburden Pressure at Base of Foundation (for qNq term) Note that AASHTO is in error. This should be total stress, not effective stress. At least this mistake is conservative:

$$q := \begin{cases} (D_f - GWT) \cdot (\gamma_{sub}) + (GWT \cdot \gamma) & \text{if } GWT < D_f \\ D_f \gamma & \text{otherwise} \end{cases}$$ $q = 119.0\,\text{psf}$ $q = 5.7\,\text{kPa}$

Calculate Bearing Capacity Factors:

$$N_q := \exp(\pi \cdot \tan(\phi)) \cdot \tan\left(45\text{deg} + \frac{\phi}{2}\right)^2$$ $N_q = 1$

$$N_c := \max\left[(N_q - 1) \cdot \cot(\max(\phi, 1)), 5.14\right]$$ $N_c = 5.14$

$$N_\gamma := 2 \cdot (N_q + 1) \cdot \tan(\phi)$$ $N_\gamma = 0$

Calculate Weighted Average Soil Unit Weight:

$$D := \left(0.5 \cdot B \cdot \tan\left(45deg + \frac{\phi}{2}\right)\right)$$ (D only used if phi >= 37 degrees)

$$\gamma := \begin{cases} \begin{cases} \gamma_{sub} + \left(\frac{z_w}{B}\right) \cdot (\gamma - \gamma_{sub}) & \text{if } \phi < 37 \cdot deg \\ (2 \cdot D - z_w) \cdot \left(\frac{z_w \cdot \gamma}{D^2}\right) + \frac{\gamma_{sub}}{D^2} \cdot (D - z_w)^2 & \text{otherwise} \end{cases} & \text{if } (z_w < B) \wedge (z_w > 0) \\ \gamma_{sub} & \text{if } z_w \le 0 \\ \gamma & \text{otherwise} \end{cases}$$

$\gamma = 47.6\,pcf$

Calculate Footing Shape Factors:

$$s_c := \begin{cases} 1 + \left(\frac{B'}{L'}\right) \cdot \left(\frac{N_q}{N_c}\right) & \text{if } L' < 5 \cdot B' \\ 1 & \text{otherwise} \end{cases}$$

$s_c = 1.195$

$$s_q := \begin{cases} 1 + \left(\frac{B'}{L'}\right) \cdot \tan(\phi) & \text{if } L' < 5 \cdot B' \\ 1 & \text{otherwise} \end{cases}$$

$s_q = 1.000$

$$s_\gamma := \begin{cases} 1 - 0.4 \cdot \left(\frac{B'}{L'}\right) & \text{if } L' < 5 \cdot B' \\ 1 & \text{otherwise} \end{cases}$$

$s_\gamma = 0.600$

Calculate Inclined Loading Factors:

$$n := \left(\frac{2 + \frac{L'}{B'}}{1 + \frac{L'}{B'}}\right) \cdot \cos(\theta)^2 + \left(\frac{2 + \frac{B'}{L'}}{1 + \frac{B'}{L'}}\right) \cdot \sin(\theta)^2$$

$n = 1.5$

$$i_q := \left(1 - \frac{P}{Q + B' \cdot L' \cdot c \cdot \cot(\max(\phi, 1))}\right)^n$$

$i_q = 1$

$$i_c := \begin{cases} i_q - \left(\frac{1 - i_q}{N_c \cdot \tan(\phi)}\right) & \text{if } \phi > 0deg \\ 1 - \left(\frac{n \cdot P}{B' \cdot L' \cdot c \cdot N_c}\right) & \text{otherwise} \end{cases}$$

$i_c = 1$

$$i_\gamma := \left(1 - \frac{P}{Q + B' \cdot L' \cdot c \cdot \cot(\max(\phi, 1))}\right)^{n+1}$$

$i_\gamma = 1$

Calculate Transverse Eccentricity - Footing Width Ratio for Two-Axis Eccentricity (For Figure 4.4.7.1.1C):

$ER_t := \frac{e_B}{B}$ $\quad$ $ER_t = 0$

Calculate Longitudial Eccentricity - Footing Length Ratio for Two-Axis Eccentricity (For Figure 4.4.7.1.1C):

$ER_l := \frac{e_L}{L}$ $\quad$ $ER_l = 0$

Calculate Maximum Footing Contact Pressure for Footing Loaded Eccentrically About Two Axes:

$q_{max} := K \cdot \frac{R}{B \cdot L}$

Calculate the Maximum Resistance Force Between Footing and Foundation Soil for Sliding Failure:

$P_{max} := Q \cdot \tan(\delta) + B \cdot L \cdot c_a$ $\quad$ $P_{max} = 0.0\,\text{kip}$ $\quad$ $P_{max} = 0.0\,\text{kN}$

Calculate the Factor of Safety Against Sliding Failure:

$FS_s := \frac{P_{max}}{P}$ $\quad$ $FS_s = 0.00$

Check Sliding Factor of Safety:

$Check_1 := \begin{cases} 1 & \text{if } FS_s \geq 1.5 \\ 0 & \text{otherwise} \end{cases}$ $\quad$ $Check_1 = 0$

If $Check_1 = 0$, sliding factor of safety below acceptable value.

Calculate Ultimate Bearing Capacity:

$q_{ult} := \begin{cases} c \cdot N_c \cdot s_c \cdot i_c + 0.5 \cdot \gamma \cdot B \cdot N_\gamma \cdot s_\gamma \cdot i_\gamma + q \cdot N_q \cdot s_q \cdot i_q & \text{if } j = 0\text{deg} \\ c \cdot N_{cq} \cdot s_c \cdot i_c + 0.5 \cdot \gamma \cdot B \cdot N_{\gamma q} \cdot s_\gamma \cdot i_\gamma & \text{otherwise} \end{cases}$ $\quad$ $q_{ult} = 9.3\,\text{ksf}$ $\quad$ $q_{ult} = 446.7\,\text{kPa}$

Calculate Allowable Bearing Capacity:

$q_{all} := \frac{q_{ult}}{SF}$ $\quad$ $q_{all} = 3.7\,\text{ksf}$ $\quad$ $q_{all} = 178.7\,\text{kPa}$

Revisions 0610 - correct inclined load factors and θ. θ is the angle of horizontal load orientation away from the footing long axis L, does not have a vertical component.

CALCULATION OF 2002 AASHTO BEARING CAPACITY

Location: Wheel and Track Loads, Bella Vista CHannel
Foundation: Bearing Capacity Below 30" rip-rap layer -1 Frictional

References

1. AASHTO, 2002, Standard Specifications for Highway Bridges, 17th Edition, American Association of State Highway and Transportation Officials.

Assumptions

1. Bearing capacity calculations account for foundation shape, possibility of local or punching shear, inclined load, eccentric loading, sloping ground, and ground water.
2. Calculations assume one, homogeneous soil unit.

Unit Conversions

Checked By:

$psf := \frac{lbf}{ft^2}$ $pcf := \frac{lbf}{ft^3}$ $kip := 1000lbf$ $ksf := \frac{kip}{ft^2}$ $kPa := 1000Pa$ $kN := 1000N$ $kJ := 1000J$

Input Data

Checked By:

Soil Cohesion:	$c := 0psf$	$c = 0.0\,kPa$
Soil Friction Angle:	$\phi := 28deg$	
Total Soil Unit Weight:	$\gamma := 110pcf$	$\gamma = 17.3\,\frac{kN}{m^3}$
Depth of Foundation Base below Ground Surface:	$D_f := 2.5ft$	$D_f = 0.76\,m$
Depth of Ground Water from Ground Surface:	$GWT := 0ft$	$GWT = 0.00$
Foundation Width B (For Circular Footings B = L):	$B := 1ft$	$B = 0.30\,m$
Foundation Length L:	$L := 1ft$	$L = 0.30\,m$
Slope of Adjacent Ground:	$j := 0deg$	
Is Local or Punching Shear Possible (Yes = "Y" and No = "N")?	$F_{ps} := "N"$	
Axial Force on Footing (Vertical):	$Q := 6.2kip$	
Horizontal Force on Footing (Enter 0 for vertical load):	$P := 0kip$	$F = 0.0\,\frac{s^6 \cdot A^2}{kg^2 \cdot m^3}\,k$
Angle of Load Eccentricity (0 indicates F load is parallel to L axis, 90 B axis):	$\theta := 0deg$	
Moment in x-Dimension (Footing Width):	$M_x := 0kip \cdot ft$	$M_x = 0.0\,kJ$
Moment in y-Dimension (Footing Length):	$M_y := 0kip \cdot ft$	$M_y = 0.0\,kJ$
Adhesion Between Footing and Foundation Soil (Enter 0 for vertical load):	$c_a := 0psf$	$c_a = 0.0\,kPa$
Angle of Friction Between Footing and Foundation Soil (Enter 0 for vertical load):	$\delta := 0.8 \cdot \phi$	
Cohesionless Sloping Ground Bearing Capacity Factor:	$N_{\gamma q} := 0$	
Cohesive Sloping Ground Bearing Capacity Factor:	$N_{cq} := 0$	
Bearing Capacity Safety Factor:	$SF := 2.5$	

Calculate Reduced Shear Strength Parameters if Local or Punching Shear is Possible:

$c := \begin{cases} 0.67 \cdot c & \text{if } F_{ps} = \text{"Y"} \\ c & \text{otherwise} \end{cases}$ $c = 0.0\,\text{psf}$ $c = 0.0\,\text{kPa}$

$\phi := \begin{cases} \text{atan}(0.67 \cdot \tan(\phi)) & \text{if } F_{ps} = \text{"Y"} \\ \phi & \text{otherwise} \end{cases}$ $\phi = 28\,\text{deg}$

Calculate Eccentricity in Footing "B" Direction:

$e_B := \frac{M_y}{Q}$ $e_B = 0.0\,\text{ft}$ $e_B = 0.00$

Calculate Eccentricity in Footing "L" Direction:

$e_L := \frac{M_x}{Q}$ $e_L = 0.0\,\text{ft}$ $e_L = 0.00$

Calculate Eccentric Loading Reduced Footing Dimensions:

$B' := B - 2 \cdot e_B$ $B' = 1.0\,\text{ft}$ $B' = 0.30\,\text{m}$

$L' := L - 2 \cdot e_L$ $L' = 1.0\,\text{ft}$ $L' = 0.30\,\text{m}$

Determine Effective Footing Dimensions based on any Eccentricity:

$B' := \begin{cases} B' & \text{if } e_B > 0\text{ft} \\ B & \text{otherwise} \end{cases}$ $B' = 1.0\,\text{ft}$ $B' = 0.30\,\text{m}$

$L' := \begin{cases} L' & \text{if } e_L > 0\text{ft} \\ L' & \text{otherwise} \end{cases}$ $L' = 1.0\,\text{ft}$ $L' = 0.30\,\text{m}$

Calculate the Eccentric Loading Effective Footing Area:

$A' := |B' \cdot L'|$ $A' = 1.0\,\text{ft}^2$ $A' = 0.09\,\text{m}^2$

Calculate Buoyant (Saturated) Soil Unit Weight:

$\gamma_{sub} := \gamma - 62.4\text{pcf}$ $\gamma_{sub} = 47.6\,\text{pcf}$ $\gamma_{sub} = 7.5\,\frac{\text{kN}}{\text{m}^3}$

Calculate the Depth of Ground Water Below the Base of Foundation:

$z_w := GWT - D_f$ $z_w = -2.5\,\text{ft}$ $z_w = -0.76\,\text{m}$

Calculate Eff Overburden Pressure at Base of Foundation (for qNq term) Note that AASHTO is in error. This should be total stress, not effective stress. At least this mistake is conservative:

$q := \begin{cases} (D_f - GWT) \cdot (\gamma_{sub}) + (GWT \cdot \gamma) & \text{if } GWT < D_f \\ D_f \cdot \gamma & \text{otherwise} \end{cases}$ $q = 119.0\,\text{psf}$ $q = 5.7\,\text{kPa}$

Calculate Bearing Capacity Factors:

$N_q := \exp(\pi \cdot \tan(\phi)) \cdot \tan\left(45\text{deg} + \frac{\phi}{2}\right)^2$ $N_q = 14.72$

$N_c := (N_q - 1) \cdot \cot(\phi)$ $N_c = 25.803$

$N_\gamma := 2 \cdot (N_q + 1) \cdot \tan(\phi)$ $N_\gamma = 16.717$

Calculate Weighted Average Soil Unit Weight:

$$D := \left(0.5 \cdot B \cdot \tan\left(45deg + \frac{\phi}{2}\right)\right)$$

(D only used if phi >= 37 degrees)

$$\gamma := \begin{cases} \begin{cases} \gamma_{sub} + \left(\frac{z_w}{B}\right) \cdot (\gamma - \gamma_{sub}) & \text{if } \phi < 37 \cdot deg \\ (2 \cdot D - z_w) \cdot \left(\frac{z_w \cdot \gamma}{D^2}\right) + \frac{\gamma_{sub}}{D^2} \cdot (D - z_w)^2 & \text{otherwise} \end{cases} & \text{if } (z_w < B) \wedge (z_w > 0) \\ \gamma_{sub} & \text{if } z_w \le 0 \\ \gamma & \text{otherwise} \end{cases}$$

$\gamma = 47.6\ pcf$

Calculate Footing Shape Factors:

$$s_c := \begin{cases} 1 + \left(\frac{B'}{L'}\right) \cdot \left(\frac{N_q}{N_c}\right) & \text{if } L' < 5 \cdot B' \\ 1 & \text{otherwise} \end{cases}$$

$s_c = 1.570$

$$s_q := \begin{cases} 1 + \left(\frac{B'}{L'}\right) \cdot \tan(\phi) & \text{if } L' < 5 \cdot B' \\ 1 & \text{otherwise} \end{cases}$$

$s_q = 1.532$

$$s_\gamma := \begin{cases} 1 - 0.4 \cdot \left(\frac{B'}{L'}\right) & \text{if } L' < 5 \cdot B' \\ 1 & \text{otherwise} \end{cases}$$

$s_\gamma = 0.600$

Calculate Inclined Loading Factors:

$$n := \left(\frac{2 + \frac{L'}{B'}}{1 + \frac{L'}{B'}}\right) \cdot \cos(\theta)^2 + \left(\frac{2 + \frac{B'}{L'}}{1 + \frac{B'}{L'}}\right) \cdot \sin(\theta)^2$$

$n = 1.5$

$$i_q := \left(1 - \frac{P}{Q + B' \cdot L' \cdot c \cdot \cot(\phi)}\right)^n$$

$i_q = 1$

$$i_c := \begin{cases} i_q - \left(\frac{1 - i_q}{N_c \cdot \tan(\phi)}\right) & \text{if } \phi > 0deg \\ 1 - \left(\frac{n \cdot F}{B' \cdot L' \cdot c \cdot N_c}\right) & \text{otherwise} \end{cases}$$

$i_c = 1$

$$i_\gamma := \left(1 - \frac{P}{Q + B' \cdot L' \cdot c \cdot \cot(\phi)}\right)^{n+1}$$

$i_\gamma = 1$

Calculate Transverse Eccentricity - Footing Width Ratio for Two-Axis Eccentricity (For Figure 4.4.7.1.1C):

$$ER_t := \frac{e_B}{B}$$ $ER_t = 0$

Calculate Longitudial Eccentricity - Footing Length Ratio for Two-Axis Eccentricity (For Figure 4.4.7.1.1C):

$$ER_l := \frac{e_L}{L}$$ $ER_l = 0$

Calculate Maximum Footing Contact Pressure for Footing Loaded Eccentrically About Two Axes:

$$q_{max} := K\cdot\frac{R}{B\cdot L}$$

Calculate the Maximum Resistance Force Between Footing and Foundation Soil for Sliding Failure:

$$P_{max} := Q\cdot\tan(\delta) + B\cdot L\cdot c_a$$ $P_{max} = 2.6\,kip$ $P_{max} = 11.4\,kN$

Calculate the Factor of Safety Against Sliding Failure:

$$FS_s := \frac{P_{max}}{P}$$ $FS_s = ▮$

Check Sliding Factor of Safety:

$$Check_1 := \begin{cases} 1 & \text{if } FS_s \geq 1.5 \\ 0 & \text{otherwise} \end{cases}$$

$Check_1 = ▮$

If $Check_1 = 0$, sliding factor of safety below acceptable value.

Calculate Ultimate Bearing Capacity:

$$q_{ult} := \begin{cases} c\cdot N_c\cdot s_c\cdot i_c + 0.5\cdot\gamma\cdot B\cdot N_\gamma\cdot s_\gamma\cdot i_\gamma + q\cdot N_q\cdot s_q\cdot i_q & \text{if } j = 0deg \\ c\cdot N_{cq}\cdot s_c\cdot i_c + 0.5\cdot\gamma\cdot B\cdot N_{\gamma q}\cdot s_\gamma\cdot i_\gamma & \text{otherwise} \end{cases}$$

$q_{ult} = 2.9\,ksf$ $q_{ult} = 139.9\,kPa$

Calculate Allowable Bearing Capacity:

$$q_{all} := \frac{q_{ult}}{SF}$$ $q_{all} = 1.2\,ksf$ $q_{all} = 56.0\,kPa$

Revisions 0610 - correct inclined load factors and θ. θ is the angle of horizontal load orientation away from the footing long axis L, does not have a vertical component.

Steamboat Creek
WSP & Freeboard Table 11-30-06

HEC-RAS Plan: findes092106 River: Steamboat Reach: Bella Vista Profile: PF 1

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	Min Ch El Sta (ft)	W.S. Elev (ft)	Vel Chnl (ft/s)	Max Chl Dpth (ft)	LOB Elev (ft)	L. Freeboard (ft)	Hydr Depth (ft)
Bella Vista	90	PF 1	4200	4445.9	210	4450.97	5.8	5.07	4452.3	1.33	4.76
Bella Vista	89.5	PF 1	4200	4443.35	194	4450.86	5.3	7.51	4453.2	2.34	5.4
Bella Vista	89	PF 1	4200	4443.2	194	4450.67	5.7	7.47	4453.1	2.43	5.33
Bella Vista	88.5	PF 1	4200	4443.05	194	4450.46	6.2	7.41	4453.05	2.59	5.32
Bella Vista	88	PF 1	4200	4442.9	194	4450.06	7.1	7.16	4452.9	2.84	5.13
Bella Vista	87.7625*	PF 1	4200	4442.83	197	4449.87	7.3	7.04	4452.83	2.96	5
Bella Vista	87.525*	PF 1	4200	4442.75	200	4449.64	7.6	6.89	4452.75	3.11	4.82
Bella Vista	87.2875*	PF 1	4200	4442.67	203	4449.34	8	6.67	4452.67	3.33	4.55
Bella Vista	87.05	PF 1	4200	4442.6	206	4448.22	10.6	5.62	4452.6	4.38	3.47
Bella Vista	86.965*	PF 1	4200	4441.67	206	4446.04	15.4	4.37	4452.23	6.19	2.3
Bella Vista	86.88*	PF 1	4200	4440.73	206	4444.64	17.8	3.91	4451.85	7.21	1.91
Bella Vista	86.795*	PF 1	4200	4439.79	206	4443.36	19.7	3.57	4451.48	8.12	1.66
Bella Vista	86.71	PF 1	4200	4438.86	206	4442.16	21.2	3.3	4451.1	8.94	1.48
Bella Vista	86.68	PF 1	4200	4438.86	206	4442.36	20.6	3.5	4446.86	4.5	1.7
Bella Vista	86.46*	PF 1	4200	4438.53	206	4442.1	19.7	3.57	4446.53	4.43	1.77
Bella Vista	86.24*	PF 1	4200	4438.19	206	4441.82	19.1	3.63	4446.19	4.37	1.83
Bella Vista	86.02	PF 1	4200	4437.86	206	4441.54	18.6	3.68	4445.86	4.32	1.88
Bella Vista	86	PF 1	4200	4437.86	206	4441.28	18.9	3.42	4453	11.72	1.66
Bella Vista	85.925*	PF 1	4200	4437.57	206	4441.07	19.1	3.5	4452.96	11.89	1.61
Bella Vista	85.85*	PF 1	4200	4437.29	206	4440.89	19.2	3.6	4452.92	12.03	1.61
Bella Vista	85.7749*	PF 1	4200	4437	206	4440.69	19.4	3.69	4452.89	12.2	1.6
Bella Vista	85.7	PF 1	4200	4436.71	206	4440.5	19.5	3.79	4452.85	12.35	1.59
Bella Vista	85.6*	PF 1	4200	4436.69	203.69	4440.55	18.3	3.86	4452.81	12.26	1.65
Bella Vista	85.5*	PF 1	4200	4436.67	201.37	4443.15	6.8	6.48	4452.76	9.61	4.15
Bella Vista	85.3999*	PF 1	4200	4436.66	199.06	4443.08	6.8	6.41	4452.72	9.65	4.08
Bella Vista	85.3*	PF 1	4200	4436.64	196.74	4443.01	6.7	6.37	4452.67	9.66	4.03
Bella Vista	85.2	PF 1	4200	4436.62	194.43	4442.94	6.5	6.32	4452.63	9.69	3.98
Bella Vista	85.16	PF 1	4200	4436.61	193.5	4442.92	6.5	6.31	4452.61	9.69	3.97
Bella Vista	85	PF 1	4200	4436.58	192.8	4442.96	5.6	6.38	4445.32	2.36	4.01
Bella Vista	84.5		Lat Struct								
Bella Vista	84	PF 1	4094	4436.4	184.8	4442.77	4.8	6.37	4444.9	2.13	3.98
Bella Vista	83	PF 1	4094	4436.22	183.4	4442.57	4.7	6.35	4444.72	2.15	3.96
Bella Vista	82	PF 1	4094	4436.04	188.9	4442.36	4.8	6.32	4444.54	2.18	3.94
Bella Vista	81	PF 1	4094	4435.86	201.2	4442.15	4.8	6.29	4444.36	2.21	3.91
Bella Vista	80	PF 1	4094	4435.68	219.5	4441.93	4.9	6.25	4444.18	2.25	3.88
Bella Vista	79	PF 1	4094	4435.5	231.3	4441.69	4.9	6.19	4444	2.31	3.82
Bella Vista	78	PF 1	4094	4435.32	230.2	4441.44	5	6.12	4443.82	2.38	3.76
Bella Vista	77	PF 1	4094	4435.14	230.4	4441.17	5.1	6.03	4443.64	2.47	3.67
Bella Vista	76	PF 1	4094	4434.96	238.1	4440.86	5.3	5.9	4443.46	2.6	3.55
Bella Vista	75.25	PF 1	4094	4434.83	245.5	4440.47	5.8	5.64	4443.33	2.86	3.3
Bella Vista	75	PF 1	4094	4434.78	247.4	4440.22	6.1	5.44	4443.28	3.06	3.12
Bella Vista	74.75	PF 1	4094	4433.74	249.1	4440.3	4.5	6.55	4443.24	2.95	4.08
Bella Vista	74	PF 1	4094	4433.6	252.5	4440.13	4.6	6.53	4443.1	2.97	4.06
Bella Vista	73	PF 1	4094	4433.42	253.2	4439.98	4.5	6.56	4442.92	2.94	4.08
Bella Vista	72	PF 1	4094	4433.24	249.7	4439.82	4.5	6.58	4442.74	2.92	4.1
Bella Vista	71	PF 1	4094	4433.06	241.9	4439.67	4.5	6.61	4442.56	2.89	4.13
Bella Vista	70	PF 1	4094	4432.88	229.9	4439.53	4.4	6.65	4442.38	2.85	4.1
Bella Vista	69	PF 1	4094	4432.7	209.5	4439.39	4.4	6.69	4442.2	2.81	4.2
Bella Vista	68	PF 1	4094	4432.52	184.7	4439.26	4.3	6.73	4442.02	2.77	4.25
Bella Vista	67	PF 1	4094	4432.34	164.3	4439.12	4.3	6.78	4441.84	2.72	4.29
Bella Vista	66	PF 1	4094	4432.16	152.9	4439	4.2	6.84	4441.66	2.66	4.33
Bella Vista	65	PF 1	4094	4431.98	150.3	4438.88	4.2	6.9	4441.48	2.6	4.38
Bella Vista	64	PF 1	4094	4431.8	155.8	4438.76	4.1	6.96	4441.3	2.54	4.44
Bella Vista	63	PF 1	4094	4431.62	162.1	4438.66	4.1	7.04	4441.12	2.46	4.5
Bella Vista	62	PF 1	4094	4431.44	166.96	4438.55	4	7.11	4440.94	2.39	4.57
Bella Vista	61	PF 1	4094	4431.26	170.37	4438.47	3.8	7.21	4440.76	2.29	4.75
Bella Vista	60	PF 1	4094	4431.08	181.03	4438.38	3.6	7.3	4441.08	2.7	4.83
Bella Vista	59	PF 1	4094	4430.9	205.11	4438.29	3.6	7.39	4440.9	2.61	4.91

HEC-RAS Plan: findes092106 River: Steamboat Reach: Bella Vista Profile: PF 1

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	Min Ch El Sta (ft)	W.S. Elev (ft)	Vel Chnl (ft/s)	Max Chl Dpth (ft)	LOB Elev (ft)	L. Freeboard (ft)	Hydr Depth (ft)
Bella Vista	58	PF 1	4094	4430.72	216.49	4438.21	3.5	7.49	4440.72	2.51	5
Bella Vista	57	PF 1	4094	4430.54	209.8	4438.13	3.4	7.59	4440.54	2.41	5.09
Bella Vista	56	PF 1	4094	4430.36	185.19	4438.06	3.4	7.7	4440.36	2.3	5.19
Bella Vista	55	PF 1	4594	4430.18	152.54	4437.93	3.7	7.75	4440.18	2.25	5.25
Bella Vista	54	PF 1	5194	4430	143.25	4437.73	4.4	7.73	4440	2.27	5.2
Bella Vista	53	PF 1	5694	4429.82	156.82	4437.54	4.8	7.72	4439.82	2.28	5.23
Bella Vista	52	PF 1	6194	4429.64	188.6	4437.31	5.2	7.67	4439.64	2.33	5.19
Bella Vista	51	PF 1	6194	4429.46	221.81	4437.11	5.3	7.65	4439.46	2.35	5.16
Bella Vista	50	PF 1	6194	4429.28	240.45	4436.92	5.4	7.64	4439.28	2.36	5.15
Bella Vista	49.65		Lat Struct								
Bella Vista	49	PF 1	6139	4429.1	250.56	4436.74	5.3	7.64	4439.1	2.36	5.15
Bella Vista	48	PF 1	6139	4428.92	254.24	4436.56	5.3	7.64	4438.92	2.36	5.15
Bella Vista	47	PF 1	6139	4428.74	251.47	4436.38	5.3	7.64	4438.74	2.36	5.15
Bella Vista	46	PF 1	6139	4428.56	242.27	4436.2	5.3	7.64	4438.56	2.36	5.15
Bella Vista	45	PF 1	6139	4428.38	226.72	4436.02	5.3	7.64	4438.62	2.6	5.14
Bella Vista	44	PF 1	6139	4428.2	204.93	4435.81	5.4	7.61	4438.44	2.63	5.07
Bella Vista	43	PF 1	6139	4428.02	177.19	4435.62	5.4	7.6	4438.26	2.64	5.07
Bella Vista	42	PF 1	6139	4427.84	152.68	4435.45	5.4	7.61	4438.08	2.63	5.01
Bella Vista	41	PF 1	6139	4427.66	145.52	4435.27	5.4	7.61	4437.9	2.63	5.01
Bella Vista	40	PF 1	6139	4427.48	152.44	4435.11	5.4	7.63	4437.72	2.62	5.02
Bella Vista	39	PF 1	6139	4427.3	167.27	4434.94	5.4	7.64	4437.54	2.6	5.03
Bella Vista	38	PF 1	6139	4427.12	190.17	4434.77	5.3	7.65	4437.36	2.59	5.05
Bella Vista	37	PF 1	6139	4426.94	218.51	4434.61	5.3	7.67	4437.18	2.57	5.06
Bella Vista	36	PF 1	6139	4426.76	241.21	4434.44	5.3	7.68	4437	2.56	5.08
Bella Vista	35	PF 1	6139	4426.58	253.88	4434.28	5.3	7.7	4436.82	2.54	5.09
Bella Vista	34	PF 1	6139	4426.4	251.35	4434.12	5.3	7.72	4436.64	2.52	5.11
Bella Vista	33	PF 1	6139	4426.22	234.48	4433.97	5.2	7.75	4436.46	2.49	5.13
Bella Vista	32	PF 1	6139	4426.04	210.95	4433.81	5.2	7.77	4436.28	2.47	5.16
Bella Vista	31	PF 1	6139	4425.86	186.76	4433.66	5.2	7.8	4436.1	2.44	5.18
Bella Vista	30	PF 1	6139	4425.68	163.74	4433.51	5.2	7.83	4435.92	2.41	5.21
Bella Vista	29	PF 1	6139	4425.5	149.71	4433.37	5.1	7.87	4435.74	2.37	5.23
Bella Vista	28	PF 1	6139	4425.32	145.84	4433.23	5.1	7.91	4435.56	2.33	5.26
Bella Vista	27	PF 1	6139	4425.14	152	4433.09	5	7.95	4435.38	2.29	5.3
Bella Vista	26	PF 1	6139	4424.96	168.38	4432.96	5	8	4435.7	2.74	5.35
Bella Vista	25	PF 1	6139	4424.78	195.04	4432.83	4.9	8.05	4435.52	2.69	5.4
Bella Vista	24	PF 1	6139	4424.6	224.58	4432.71	4.9	8.11	4435.34	2.63	5.45
Bella Vista	23	PF 1	6139	4424.42	246.48	4432.59	4.8	8.17	4435.16	2.57	5.04
Bella Vista	22	PF 1	6139	4424.24	255.62	4432.48	4.7	8.24	4434.98	2.5	5.06
Bella Vista	21	PF 1	6139	4424.06	252.94	4432.36	4.7	8.3	4434.8	2.44	5.6
Bella Vista	20	PF 1	6139	4423.88	237.83	4432.26	4.7	8.38	4434.62	2.36	5.67
Bella Vista	19	PF 1	6139	4423.7	202.73	4432.16	4.6	8.46	4434.44	2.28	5.24
Bella Vista	18	PF 1	6139	4423.52	1658.44	4432.06	4.5	8.54	4434	1.94	5.17