

NORTHWEST SPECIFIC PLAN

Master Plan Hydrology Report



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Table of Contents

| | | |
|-------|---|----|
| 1. | Introduction | 1 |
| 1.1 | General | 1 |
| 1.2 | Project Location | 1 |
| 1.3 | Purpose | 1 |
| 1.4 | Scope | 1 |
| 2. | Document Review | 6 |
| 3. | Hydrology | 7 |
| 3.1 | Existing Site Conditions | 7 |
| 3.2 | Future Site Conditions | 7 |
| 3.3 | Review of “Hydrology Study, Lands of Faria” | 8 |
| 3.3.1 | General | 8 |
| 3.3.2 | Methodology | 8 |
| 3.3.3 | Faria Preserve Detention Evaluation | 10 |
| 3.4 | Northwest Specific Hydrologic Analysis | 11 |
| 3.4.1 | General | 11 |
| 3.4.2 | Developed Site Runoff | 14 |
| 3.5 | Chu Property Stormwater Detention Basins | 17 |
| 4. | Conclusion | 18 |
| 5. | References | 20 |

List of Figures

| | |
|--|-------------------|
| FIGURE 1: AREA LOCATION MAP | 3 |
| FIGURE 2: AERIAL PHOTO MAP | 4 |
| FIGURE 3: GENERAL DETENTION BASIN LOCATION | 5 |
| FIGURE 4: EXISTING CONDITIONS HYDROLOGY | <u>APPENDIX A</u> |
| FIGURE 5: PROPOSED CONDITIONS HYDROLOGY | <u>APPENDIX A</u> |
| FIGURE 7: SOILS MAP | <u>APPENDIX A</u> |
| FIGURE 6: FLOOD INSURANCE RATE MAP | <u>APPENDIX C</u> |



List of Tables

| | |
|---|----|
| TABLE 1. SCS CURVE NUMBERS FROM FARIA PRESERVE STUDY. | 9 |
| TABLE 2. REVISED CURVE NUMBERS FOR FARIA PRESERVE STUDY | 10 |
| TABLE 3. INTENSITY EQUATION VARIABLES..... | 10 |
| TABLE 4. PEAKS/VOLUMES USING REVISED CURVE NUMBERS. | 11 |
| TABLE 5. FARIA PRESERVE REVISED DETENTION BASIN SIZE | 11 |
| TABLE 6. EXISTING CONDITIONS BASIN PARAMETERS. | 13 |
| TABLE 7. EXISTING CONDITIONS HEC-HMS RESULTS..... | 14 |
| TABLE 8. PROPOSED CONDITIONS BASIN PARAMETERS..... | 15 |
| TABLE 9. PROPOSED CONDITIONS HEC-HMS RESULTS. | 16 |
| TABLE 10. RECOMMENDED DETENTION VOLUME FOR THE 100-YEAR 12-HOUR STORM. | 16 |

Appendices

- Appendix A – Current Hydrology
- Appendix B – Lands of Faria Hydrology Study
- Appendix C – Additional Data

1. INTRODUCTION

1.1 GENERAL

The Northwest Specific Plan (NWSP) area is a 350-acre planned development area located outside the City of San Ramon's current city limits and within southern Contra Costa County (**Figure 1**). The NWSP is outlined in the San Ramon General Plan 2020. Property ownership in the area includes the Faria Preserve located east of Bollinger Canyon Road, the Chu property located west of Bollinger Canyon Road and the Panetta Property located west of Bollinger Canyon Road.

1.2 PROJECT LOCATION

The NWSP area is located within the City of San Ramon's (the City's) Urban Growth Boundary. As shown in **Figure 1** and **Figure 2**, the NWSP area is located in southern Contra Costa County, west of Interstate 680, and immediately south of the Town of Danville.

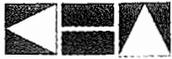
1.3 PURPOSE

The purpose of this Master Plan Hydrology Study is to review the existing hydrologic study prepared for the Faria Preserve and to complete a preliminary hydrologic analysis of the remaining area within the Northwest Specific Plan. This Master Plan Hydrology Report for the Northwest Specific Plan completes the hydrologic analysis for the planning area.

1.4 SCOPE

The work performed by Kimley-Horn and Associates, Inc. (Kimley-Horn) includes:

- Collecting and reviewing available planning documents, existing drainage and hydrology studies, topographic information and aerial photography in digital format, and hydrology models that incorporate Faria Ranch and vicinity.
- Evaluate and/or modify previous drainage studies for the project site.
- Compare pre- and post-development hydrology developed from the project site based on existing and proposed land uses.
- Prepare a Preliminary Hydrology Study for the proposed development alternative. Prepare the drainage calculations according to Contra Costa County Flood Control District and local standards. Storm water runoff for the 100-yr/12-hr and 24-hr events for both the existing and proposed development condition was determined for the project site and contributing watershed. The more conservative of the results for these two storm events in regards to peak discharges and runoff volumes were used in subsequent detention basin requirements.
- Evaluate existing drainage basin outfalls and proposed drainage basin outfalls as determined in the Hydrology Study for Lands of Faria, San Ramon, Contra Costa County, CA, dated April 28, 2003 by Bellecci and Associates, Inc. This study does not include storm drain or culvert analyses.



- Locate and size detention basins for the project site within the Northwest Specific Plan Area. The proposed detention basins were incorporated into the Preliminary Hydrology to develop the Master Plan Hydrology. Kimley-Horn located and sized detention facilities to limit calculated post-development storm water runoff from the site to pre-development runoff conditions.
- Prepare a Master Plan Hydrology Report that documents the review of data collection and the development of the pre- and post-development project storm water runoff. The report also presents the recommended detention basin capacities (See **Table 5** and Section 3.5) and locations on the project site (See **Figure 3**). The report includes appropriate figures, illustrations, and tables that document hydrology results and study assumptions and criteria.

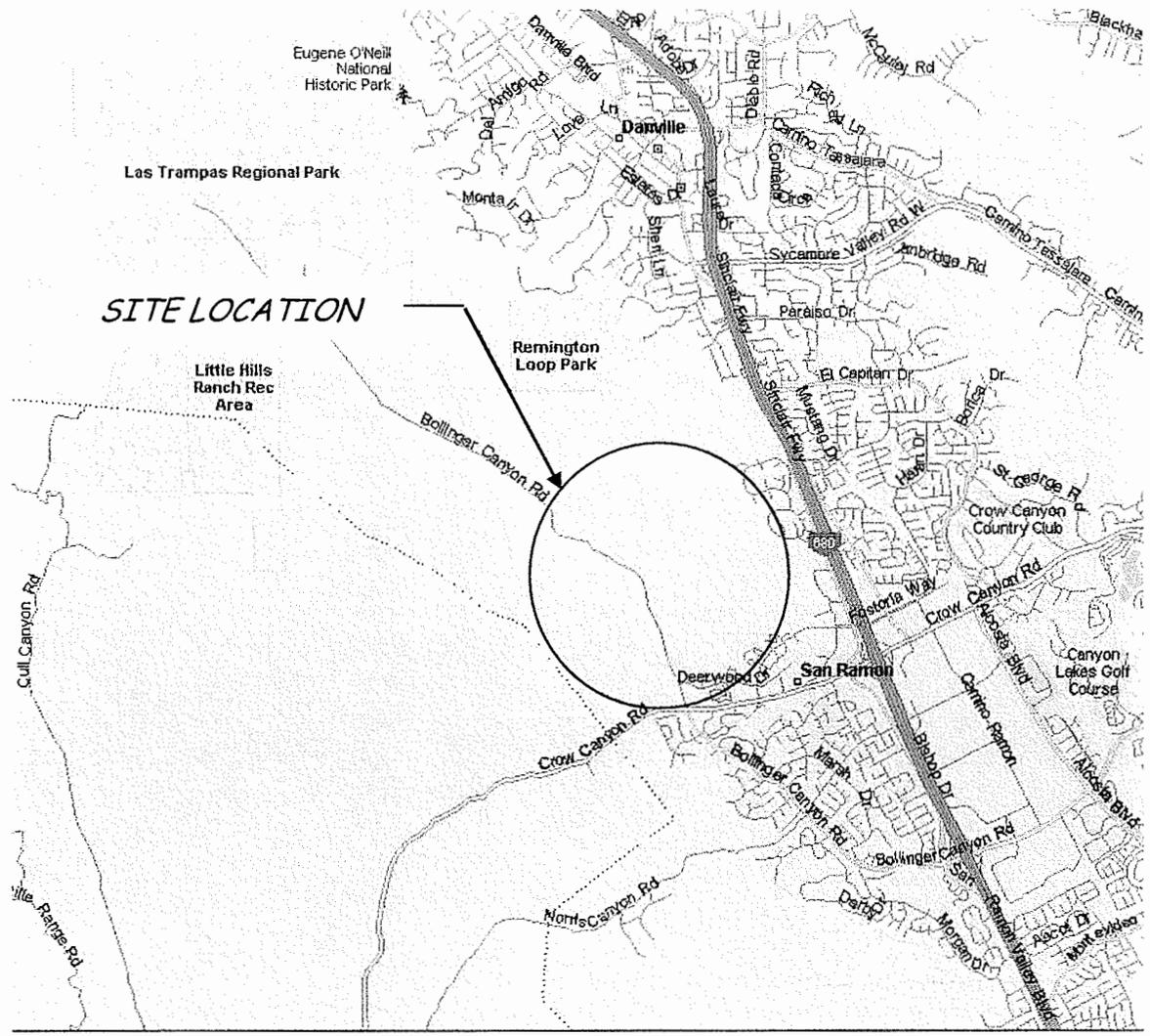


FIGURE 1
Area Location Map
Northwest Specific Plan

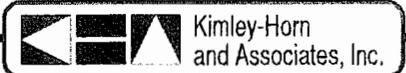




FIGURE 2
Aerial Photo Map
Northwest Specific Plan

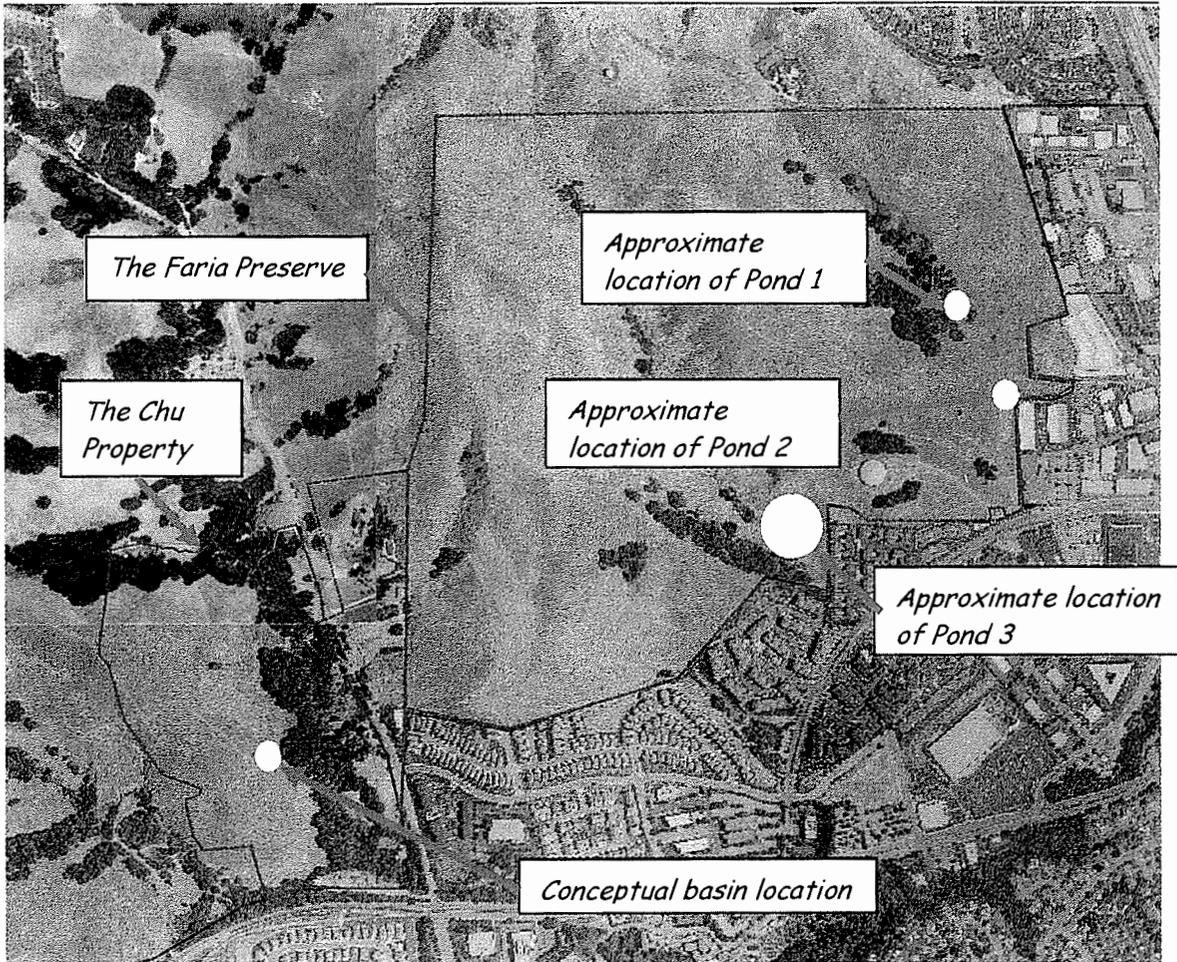


FIGURE 3
General Detention Basin Location
Northwest Specific Plan



2. DOCUMENT REVIEW

The following documents were reviewed as part of this Master Plan Hydrology Report:

Bellecci and Associates, Inc, Hydrology Study: Lands of Faria, San Ramon, Contra Costa County, CA, April 28, 2003. (Unsealed and Unsigned).

“Northwest Specific Plan Project Description” Provided by Richard Loewke of Richard T. Loewke, Urban & Environmental Planning, in electronic format.

Faria Ranch, San Ramon, California, Planning Document, dated June 3, 2003.

Conceptual Biological Mitigation and Monitoring Plan for the Faria Ranch Project, San Ramon, Contra Costa County, California, Prepared by The Huffman-Broadway Group, Inc., dated August 2004.

Contra Costa Public Works Department, Precipitation Duration-Frequency-Depth Curves, Recurrence Interval 100 years, Drawing Number B-162.

Contra Costa Public Works Department, Mean Seasonal Isohyets compiled from Precipitation Records 1879-1973, Drawing Number B-166.

EDAW Exhibits: Development Suitability, Major Ridgelines, Slope Classification, and 100-yr Floodplain.

Chu property, San Ramon, California, Proposed Lot Layout, Prepared by Donald L. Blayney & Associates, dated April 27, 2004.

Work Plan and Literature Review for the Hydrograph Modification Management Plan, Contra Costa Clean Water Program, dated February 12, 2004.

Natural Resources Conservation Service (NRCS) soils survey for Contra Costa County, electronic format from <http://soildatamart.nrcs.usda.gov/>.



3. HYDROLOGY

3.1 EXISTING SITE CONDITIONS

The site is situated in unformed drainage area 81 of the Contra Costa County Flood Control District. The soil composition of the area consists primarily of clay, silty clay and clay loam. This soil type is classified by the Natural Resources Conservation Service as (NRCS) as Hydrologic Soil Group B, C, or D. The characteristics of these soils are found in data tables located in Appendix A.

The site consists of open rangeland with oak woodlands and riparian corridors along ephemeral drainage ways. Natural runoff within the easterly portion of the NWSP flows in a southeast direction, and enters municipal storm drainage facilities adjoining the site boundaries. These facilities eventually



discharge into San Ramon Creek. One significant existing detention basin, noted in the Hydrology Study for the Faria Preserve as Pond 3, is located north of Deerwood Road.

There are no existing detention basins in the western portion of the NWSP. Bollinger Creek flows in a southerly direction, and is located along the western property boundary of the Chu property. Currently the natural runoff from the Chu property flows in an easterly direction discharging along Bollinger Creek. **Figure 4**, located in **Appendix A**, illustrates the existing land conditions for the Chu property.

3.2 FUTURE SITE CONDITIONS

According to the City's General Plan, future development in the NWSP area will likely consist of residential units, a community park, an educational use, and a church. The residential development will be at a range of densities, from hillside residential to high-density senior housing. The proposed future land use for the Faria Preserve are illustrated and discussed in the report titled "The Hydrology Study for the Lands of Faria" and are included in **Appendix B** of this study. Future land use conditions for the Chu property are illustrated in **Figure 5**, located in **Appendix A**. The future land use conditions for the Chu property is based on the Proposed Lot Layout Prepared by Donald L. Blayney & Associates, dated April 27, 2004, a copy is included in **Appendix C**.



3.3 REVIEW OF “HYDROLOGY STUDY, LANDS OF FARIA”

3.3.1 General

Kimley-Horn reviewed an unsigned and unsealed hydrology study report that was completed for the Faria Preserve by Bellecci and Associates in April 2003 titled “Hydrology Study, Lands of Faria.” The area studied in the Bellecci and Associates report was noted as the Lands of Faria. The Lands of Faria has since been segmented into the Faria Preserve and the Lands of Faria. The portion of the property within the NWSP boundaries is referred to as the Faria Preserve. The remaining land, which is outside of the NWSP boundaries, is noted as Lands of Faria and is not addressed in this study. To avoid any further confusion, the hydrology study completed by Bellecci and Associates will be noted as the Faria Preserve Hydrology. An addendum to the original report was prepared by Bellecci & Associates Inc. on April 22, 2004, a copy of has been reviewed as part of this Master Plan Hydrology Report.

Additional information was forwarded to Kimley-Horn by Bellecci and Associates. This backup documentation was used by Kimley-Horn to complete an evaluation of the existing hydrologic conditions noted in the Bellecci and Associates hydrology study. The additional information provided to Kimley-Horn is located in **Appendix B**.

The hydrologic methods used by Bellecci to determine peak discharges and drainage basin volumes are common and widely used engineering methods. In addition, as stated on page 2 of 6 in the Hydrology Study for the Faria Preserve, “All calculations were done in accordance with the Contra Costa County Flood Control District Design Criteria. Our review of the Bellecci report indicates that Bellecci may have conducted the hydrologic computations according to criteria, but KHA has found an incorrect application of soils parameters in the Bellecci Study. Further discussion is provided below in section 3.3.2 Rational Losses/Curve Numbers.

To remain consistent runoff calculations for drainage basins analyzed as part of this Master Plan Hydrology Report were determined using the methodologies consistent with the Faria Preserve Hydrology. The Faria Preserve Hydrology Study used a hydrograph routing program called PondPack to route the storm water runoff through retention basins and used the Rational Method in the StormCAD program to calculate peak discharge values for all other drainage basins within the Faria Preserve.

3.3.2 Methodology

Precipitation

The hydrology study for the Faria Preserve analyzed the 100-year, 12-hour, and the 100-yr, 24-hour design storms. From this analysis, the report concluded the 100-year, 12-hour storm presented a more critical storm compared to the 100-year, 24-hour storm. Therefore, the 100-year, 12-hour storm discharge values are used in the Faria study. The mean annual precipitation of 22.5 inches was found using the County Mean Seasonal Isohyets, Drawing Number B-166, located in **Appendix A**. The precipitation for the 100-year, 12-hour event is 4.5 inches of depth using the Precipitation Duration-Frequency-Depth Curves Drawing Number B-162.

Rainfall Distribution

The hydrology study for the Faria Preserve used the SCS Type 1A rainfall distribution.



Unit Hydrograph

SCS Unit hydrograph method was used for basins runoff calculated using the Pond Pack program.

Time of Concentration

The time of concentration was determined using the SCS Lag Formula:

$$T_c = 0.000087 L_f^{0.5} \left(\frac{1000}{CN} - 9 \right)^{0.7} S_f^{-0.5}$$

Where: T_c = Time of Concentration (hr)

L_f = Flow Length (ft)

S_f = Slope (ft/ft)

CN = SCS curve number

Under the existing conditions analysis, the Faria Preserve study assumed a minimum time of concentration of 5 minutes. Under the proposed (developed) conditions for land use type Residential (RES) the time of concentration included an additional 5 minutes for roof-to-gutter time.

Rainfall Losses/Curve Numbers

The curve number (CN) is used in the SCS lag formula to estimate time of concentration and the lag time. Curve numbers used in the Faria Preserve Hydrology study are listed below in **Table 1**.

Table 1. SCS Curve Numbers from Faria Preserve Study.

| Land use Type | Abbreviation | ⁽¹⁾ Curve Number | Rational Coefficient |
|------------------------|--------------|-----------------------------|----------------------|
| Open Space | OS | 89 | 0.45 |
| Residential | RES | 87 | 0.50 |
| Paved Area | PAV | 98 | 0.85 |
| Commercial | COM | 95 | 0.80 |
| Townhome/ Apartment | TH | 92 | 0.70 |

(1) For hydrologic soils type D per Faria Preserve Hydrology Study

The Hydrology Study for the Faria Preserve used a CN of 89 for land use type denoted as open space. A CN of 89 is in the upper range for hydrologic soil type D with poor vegetative cover.

Kimley-Horn conducted a site visit on August 19, 2004. At that time it was observed that the grass in the open areas covered approximately 50 to 75%. Upon review of the NRCS soils survey for Contra Costa County, the soils within the NWSP area are classified as hydrologic soils groups B, C, and D. Tables in TR-55 provided the appropriate curve number for these types of soils and land use conditions. **Table 2** lists these revised/corrected values.

Table 2. Revised Curve Numbers for Faria Preserve Study

| Land use Type | Abbreviation | Type B Soils | Type C Soils | Type D Soils |
|------------------------|--------------|--------------|--------------|--------------|
| Open Space | OS | 69 | 79 | 84 |
| Residential | RES | 75 | 83 | 87 |
| Paved Area | PAV | 98 | 98 | 98 |
| Commercial | COM | 92 | 94 | 95 |
| Townhome/ Apartment | TH | 85 | 90 | 92 |

A excerpts of the SCS Curve Number tables from TR-55 is located in **Appendix A**.

Rational Method Calculation

The Rational Method was used for all drainage basins that were not tributary to an existing or proposed retention/detention basin. Peak discharge values are calculated using the following equation:

$$Q = Ci a$$

Where: Q = Peak discharge value (cfs)

C = Rational Method Coefficient (see **Table 1**)

i = Rainfall Intensity (inches/hour) curve is calculated using $i = \frac{b}{(t_c + d)}$ for various durations (tc) (see **Table 3** for variables)

a = Area of the Drainage Basin (acres)

Table 3. Intensity Equation Variables.

| Storm Event | ⁽¹⁾ Variables | | |
|-------------|--------------------------|------|-------|
| | b | d | e |
| 100-year | 9.40 | 0.32 | 0.467 |

⁽¹⁾ Full list of Variables for other storm events is located in **Appendix A**.

3.3.3 Faria Preserve Detention Evaluation

Kimley Horn recreated the hydrologic models using HEC-HMS and best available data from the Faria Preserve Study. The comparison of peak discharge values and volumes are listed in **Table 4**. These results indicate the need for increased detention volumes. For this evaluation detention basins modeled in the Faria Preserve Study were increased to reduce the peak outflow to less than the existing conditions peaks. Further evaluation should be required prior to the acceptance of the final drainage study for the Faria Preserve.

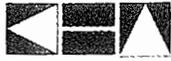


Table 4. Peaks/Volumes Using Revised Curve Numbers.

| Pond # | Existing Conditions | | | Developed Conditions | | |
|--------|---------------------|---------------------|---------------------|----------------------|--------------|-------------------|
| | Inflow Peak | Outflow Peak | Hydrograph Volume | Inflow Peak | Outflow Peak | Hydrograph Volume |
| | cfs | cfs | ac-ft | cfs | cfs | ac-ft |
| Pond 1 | NA | NA | NA | 57.6 | 24.4 | 12.5 |
| Pond 2 | NA | ⁽¹⁾ 49.8 | ⁽¹⁾ 11.3 | 84.5 | 42.7 | 22.5 |
| Pond 3 | 111.0 | 84.5 | 23.8 | 239.4 | 82.7 | 33.3 |

⁽¹⁾ Existing conditions drainage basin B.

Pond 1 and Pond 2 are planned to attenuate proposed conditions flows at drainage outlet points. Pond 1 outlets into pond 2 which appears to combine with street flows prior to entering the existing storm drain system at Purdue Road. Detention basin outlet pipes were simulated within HEC-HMS using the orifice equation. Pond 1 outlet equivalent to an 18 inch pipe, Pond 2 outlet equivalent to a 24 inch pipe and Pond 3 outlet equivalent to a 30 inch pipe. Storage volume required to reduce the peak discharge are listed below. Based on the reanalysis of the Faria Preserve hydrology, additional detention basin storage volume needs to be added within the Pond 1/Pond 2 watershed. This additional detention basin storage volume in needed to attenuate the proposed conditions peak discharge values to meet existing conditions peak discharge values.

Table 5. Faria Preserve Revised Detention Basin Size

| Pond # | Proposed Volume | Revised Volume | Additional Storage Volume Required | ⁽³⁾ Depth of Water at Peak Volume |
|--------|-----------------|--------------------|--|--|
| | ac-ft | ac-ft | ac-ft | ft |
| Pond 1 | 0.53 | ⁽¹⁾ 2.1 | 1.6 | 12.5 |
| Pond 2 | 2.4 | 1.8 | Storage Volume Adequate | 12.2 |
| Pond 3 | 1.7 | 3.6 | ⁽²⁾ Storage Volume Adequate | 13.8 |

⁽¹⁾ Pond 1 existing detention basin elevation-volume inadequate to model in HEC-HMS. Pond 2 elevation-volume relationship modeled at Pond 1 location per elevation-volume relationship from Faria Preserve PondPack model.

⁽²⁾ Storage volume contained in within existing pond based on elevation-volume relationship from Faria Preserve PondPack model.

⁽³⁾ Detention basin depth from HEC-HMS storage-elevation relationship for flows routed through basin.

3.4 NORTHWEST SPECIFIC HYDROLOGIC ANALYSIS

3.4.1 General

This Northwest Specific Hydrology Study used the hydrology program HEC-HMS Version 2.2.2 (May 28,2003) by U. S. Army Corps of Engineers to compute peak discharge values and



runoff volumes for the remaining drainage areas within the Northwest Specific Plan study limits. The hydrologic modeling matched the criteria outlined in the Faria Preserve Hydrology study, as outlined in Section 3.3 above. The HEC-HMS model was used to determine peak discharge and runoff volumes for areas within the study limits and outside the drainage basins identified by the Faria Preserve Hydrology.

The Northwest Specific study area is divided into two areas. The first area consists of the sub-basins as delineated in the Faria Preserve Hydrology. The second area consists of the additional drainage areas outside of the drainage area delineated as part of the Faria Preserve Hydrology. The outside drainage area includes the Chu property and the northeast corner of the Faria Preserve. **Figure 4**, located in **Appendix A**, shows the drainage basins analyzed in the Faria Preserve Hydrology with the additional drainage basins analyzed for this Master Plan Hydrology Report.

The delineation of the basins for existing and proposed conditions hydrologic analysis, presented in the Faria Preserve Hydrology, appear to be reasonable and were not redefined as part of this Master Plan Hydrology Report. The methods and results from the Faria Preserve Hydrology other than those noted earlier are located in **Appendix B**.

Additional drainage basins analyzed as part of this Master Plan Hydrology Report are noted as basins 005 thru 050, as depicted in **Figure 4** and **Figure 5**, located in **Appendix A**. Basin parameters used in the existing conditions hydrology model are noted in **Table 6** and results for both the 12- and 24-hour storm events are listed in **Table 7**. Basin parameters used in the proposed conditions hydrology model are noted in **Table 8** and results for both the 12- and 24-hour storm events are listed in **Table 9**.

Table 6. Existing Conditions Basin Parameters.

| Sub-Basin | Area | | Elevation | | Flow Path Length | Slope | (1) Composite Curve Number | (2) SCS Lag Tc | (3) Required minimum Tc | Tc Used | (4) SCS Lag T _L |
|-----------|-------|----------|-----------|-----|------------------|-------|----------------------------|----------------|-------------------------|---------|----------------------------|
| | Acres | Sq Miles | High | Low | | | | | | | |
| 005 | 8.7 | 0.014 | 920 | 600 | 1238 | 0.258 | 76 | 0.139 | 0.083 | 0.139 | 0.084 |
| 010 | 12.2 | 0.019 | 920 | 600 | 1570 | 0.204 | 74 | 0.201 | 0.083 | 0.201 | 0.121 |
| 015 | 20.1 | 0.031 | 920 | 600 | 1758 | 0.182 | 74 | 0.233 | 0.083 | 0.233 | 0.140 |
| 020 | 8.1 | 0.013 | 790 | 600 | 799 | 0.238 | 72 | 0.115 | 0.083 | 0.115 | 0.069 |
| 025 | 4.4 | 0.007 | 790 | 600 | 1303 | 0.146 | 73 | 0.210 | 0.083 | 0.210 | 0.126 |
| 030 | 4.9 | 0.008 | 870 | 715 | 812 | 0.191 | 79 | 0.106 | 0.083 | 0.106 | 0.063 |
| 035 | 9.8 | 0.015 | 760 | 535 | 1046 | 0.215 | 79 | 0.122 | 0.083 | 0.122 | 0.073 |
| 040 | 6.7 | 0.010 | 750 | 535 | 807 | 0.267 | 79 | 0.089 | 0.083 | 0.089 | 0.053 |
| 045 | 5.6 | 0.009 | 720 | 530 | 557 | 0.341 | 79 | 0.059 | 0.083 | 0.083 | 0.050 |
| 050 | 2.6 | 0.004 | 665 | 530 | 504 | 0.268 | 79 | 0.061 | 0.083 | 0.083 | 0.050 |

(1) Curve number based on land use spreadsheet located in **Appendix A**. A CN of 69 or 79 was used for undeveloped conditions based on the soil type for the site.

(2) Time of Concentration calculated using SCS Lag Formula: $T_c = 0.0000877 * L_r^{0.8} * (1000/CN-9)^{0.7} * S_f^{-0.5}$

Where:

T_c = Time of Concentration (hr)

L_r = Flow Length (ft)

S_f = Slope (ft/ft)

CN = SCS Curve Number for the Basin

(3) The minimum required time of concentration assumed to be 5 minutes

(4) The SCS lag time (T_L) is equal to $0.6 * T_c$

The HEC-HMS results for existing conditions are summarized in **Table 7** below.

Table 7. Existing Conditions HEC-HMS Results.

| Sub-Basin | Discharge Peak (100-yr) | | Total Volume (100-yr) | | Drainage Area |
|-----------|-------------------------|----------------|-----------------------|------------------|---------------|
| | 12-Hour cfs | 24-Hour cfs | 12-Hour ac-ft | 24-Hour ac-ft | sq mi |
| 005 | 10.66 | 8.60 | 1.59 | 2.85 | 0.014 |
| 010 | 10.96 | 10.71 | 2.00 | 3.66 | 0.019 |
| 015 | 16.38 | 17.32 | 3.26 | 5.97 | 0.031 |
| 020 | 10.03 | 6.95 | 1.26 | 2.36 | 0.013 |
| 025 | 3.73 | 3.76 | 0.71 | 1.31 | 0.007 |
| 030 | 7.65 | 5.45 | 1.01 | 1.76 | 0.008 |
| 035 | 14.35 | 10.22 | 1.90 | 3.30 | 0.015 |
| 040 | 11.36 | 6.85 | 1.27 | 2.20 | 0.010 |
| 045 | 10.22 | 6.16 | 1.14 | 1.98 | 0.009 |
| 050 | 4.54 | 2.74 | 0.51 | 0.88 | 0.004 |

3.4.2 Developed Site Runoff

Basin parameters used in the proposed hydrology model are noted in **Table 8** on the following page. The parameters provide a weighted CN that is based on the amount of land being developed versus the amount of undeveloped land or open space per drainage basin. The approximate development for the Chu property, basins 005 thru 030, was based on the Proposed Lot Layout dated April 27, 2004 (**Appendix C**). There is no planned development for the additional basins, noted as basins 035 thru 050, located within the Faria Preserve property.

Table 8. Proposed Conditions Basin Parameters.

| Sub-Basin | Area | | Undeveloped Land | | Developed Land | | Elevation | | Flow Path Length | Slope | ⁽¹⁾ Weighted Curve Number | ⁽²⁾ SCS Lag T _c | ⁽³⁾ Required minimum T _c | T _c Used | ⁽⁴⁾ SCS Lag T _L |
|-----------|-------|----------|------------------|-----|----------------|----|-----------|-----|------------------|-------|--------------------------------------|---------------------------------------|--|---------------------|---------------------------------------|
| | Acres | Sq Miles | Sq Miles | % | Sq Miles | % | High | Low | | | | | | | |
| 005 | 8.7 | 0.014 | 0.011 | 79 | 0.003 | 21 | 920 | 600 | 1238 | 0.258 | 76 | 0.223 | 0.083 | 0.223 | 0.134 |
| 010 | 12.2 | 0.019 | 0.011 | 58 | 0.008 | 42 | 920 | 600 | 1570 | 0.204 | 76 | 0.274 | 0.083 | 0.274 | 0.165 |
| 015 | 20.1 | 0.031 | 0.015 | 48 | 0.016 | 52 | 920 | 600 | 1758 | 0.182 | 74 | 0.318 | 0.083 | 0.318 | 0.191 |
| 020 | 8.1 | 0.013 | 0.008 | 62 | 0.005 | 38 | 790 | 600 | 799 | 0.238 | 74 | 0.192 | 0.083 | 0.192 | 0.115 |
| 025 | 4.4 | 0.007 | 0.004 | 57 | 0.003 | 43 | 790 | 600 | 1303 | 0.146 | 76 | 0.276 | 0.083 | 0.276 | 0.166 |
| 030 | 4.9 | 0.008 | 0.004 | 50 | 0.004 | 50 | 870 | 715 | 812 | 0.191 | 81 | 0.183 | 0.083 | 0.183 | 0.110 |
| 035 | 9.8 | 0.015 | 0.015 | 100 | 0.000 | 0 | 760 | 535 | 1046 | 0.215 | 79 | 0.122 | 0.083 | 0.122 | 0.073 |
| 040 | 6.7 | 0.010 | 0.010 | 100 | 0.000 | 0 | 750 | 535 | 807 | 0.267 | 79 | 0.088 | 0.083 | 0.088 | 0.053 |
| 045 | 5.6 | 0.009 | 0.009 | 100 | 0.000 | 0 | 720 | 530 | 557 | 0.341 | 79 | 0.058 | 0.083 | 0.083 | 0.050 |
| 050 | 2.6 | 0.004 | 0.004 | 100 | 0.000 | 0 | 665 | 530 | 504 | 0.268 | 79 | 0.061 | 0.083 | 0.083 | 0.050 |

⁽¹⁾Curve number based on land use spreadsheet located in **Appendix A**. A CN of 69 or 79 was used for undeveloped conditions based on the soil type for the site. A CN of 75 or 83 was used for developed conditions assuming the land use to be residential, 1/2 acre lots.

⁽²⁾Time of Concentration calculated using SCS Lag Formula: $T_c = 0.0000877 * L_f^{0.8} (1000/CN-9)^{0.7} * S_f^{-0.5}$ (includes a 5 min. roof to gutter travel time for land use type RES)

Where:

T_c = Time of Concentration (hr)

L_f = Flow Length (ft)

S_f = Slope (ft/ft)

CN = SCS Curve Number for the Basin

⁽³⁾The minimum required time of concentration assumed to be 5 minutes

⁽⁴⁾The SCS lag time (T_L) is equal to 0.6 * T_c



Table 9. Proposed Conditions HEC-HMS Results.

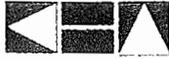
| Sub-Basin | Discharge Peak (100-yr) | | Total Volume (100-yr) | | Drainage Area |
|-----------|-------------------------|----------------|-----------------------|------------------|---------------|
| | 12-Hour cfs | 24-Hour cfs | 12-Hour ac-ft | 24-Hour ac-ft | sq mi |
| 005 | 10.33 | 8.31 | 1.53 | 2.77 | 0.014 |
| 010 | 11.78 | 11.51 | 2.16 | 3.87 | 0.019 |
| 015 | 16.00 | 17.32 | 3.26 | 5.97 | 0.031 |
| 020 | 10.72 | 7.49 | 1.37 | 2.50 | 0.013 |
| 025 | 4.30 | 4.24 | 0.80 | 1.42 | 0.007 |
| 030 | 8.66 | 5.78 | 1.09 | 1.85 | 0.008 |
| 035 | 14.34 | 10.22 | 1.90 | 3.30 | 0.015 |
| 040 | 11.35 | 6.85 | 1.27 | 2.20 | 0.010 |
| 045 | 10.22 | 6.16 | 1.14 | 1.98 | 0.009 |
| 050 | 4.54 | 2.74 | 0.51 | 0.88 | 0.004 |

For planning purposes, the required detention volume for the drainage basins outside of the Faria Preserve were determined by subtracting the proposed conditions runoff volume from the existing conditions runoff volume. The current design criteria requires that post condition peak flows are equal to or less than pre condition peak flows. To comply with the Hydrograph Modification Management Plan, the developer of the Chu property will need to consider the pre- post-peak flows at each discharge point from the Chu property.

Table 10. Recommended Detention Volume for the 100-year 12-hour storm.

| Sub-Basin | Existing Conditions Volume | Proposed Conditions Volume | Required Detention Volume |
|--------------------|----------------------------|----------------------------|---------------------------|
| | ac-ft | ac-ft | ac-ft |
| 005 | 1.59 | 1.53 | 0.06 |
| 010 | 2.00 | 2.16 | 0.16 |
| 015 | 3.26 | 3.26 | 0.00 |
| 020 | 1.26 | 1.37 | 0.011 |
| 025 | 0.71 | 0.80 | 0.09 |
| 030 | 1.01 | 1.09 | 0.08 |
| ⁽¹⁾ 035 | 1.90 | 1.90 | NA |
| ⁽¹⁾ 040 | 1.27 | 1.27 | NA |
| ⁽¹⁾ 045 | 1.14 | 1.14 | NA |
| ⁽¹⁾ 050 | 0.51 | 0.51 | NA |

⁽¹⁾No change in land use type in future conditions.



3.5 CHU PROPERTY STORMWATER DETENTION BASINS

Drainage Basins outside of the Faria Preserve were delineated as part of this Master Plan Hydrology Report. Drainage basins numbered 005 through 035 crossing the Chu property were delineated along existing ridge lines from the peak of the drainage basin area to the banks of the Bollinger Creek (See **Figure 5** in **Appendix A**). Land use for the existing conditions hydrologic evaluation was classified as Open Space.

Proposed conditions hydrologic evaluation took into account the land use change based on the proposed lot layout for the Chu property by Donald L. Blayney and Associates. Land use classification was changed from Open Space to Residential based on the preliminary lot layout for the Chu property. A conservative estimation of the retention requirements using the preliminary lot layout would be to detain the volume associated with the difference in runoff volume between pre and post conditions runoff volume. For the Chu property this volume is 0.40 acre feet. For an example, a detention basin with a 70-ft. by 70-ft. bottom width and 4 to 1 side slopes would contain the entire 0.40 acre feet with less than 3 feet of ponding depth.

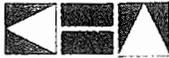
The stormwater detention basins for the Chu property will need to be located and sized to collect the contributing runoff. This will need to be completed as part of the development plans for the Chu property. Development for the Chu property will fall under the Hydrograph Modification Management Plan.

According to the Hydrograph Modification Management Plan, the developer has three options to comply with hydrograph modification best management practices (BMPs):

- 1) The applicant may demonstrate that the proposed project will not increase the peak flows and durations of site runoff, or if that fails;
- 2) The applicant may propose on-site or off-site BMP's that will mitigate the potential increases in runoff. If BMP's are not feasible, or the applicant chooses not to include them in the project plan; then
- 3) The applicant has a third option of assessing stream vulnerability to erosion.

Option 2, off-site BMPs (off-site detention/peak attenuation) was not investigated as part of this Master Plan Hydrology Report but a suitable off-site location would need to detain, for planning purposes, a minimum of 0.40 acre feet to offset the additional runoff created by the proposed Chu property development.

Compliance with criteria set forth in the Hydrograph Modification Management Plan document is the responsibility of the Chu property developer.



4. CONCLUSION

The purpose of this Master Plan Hydrology Study is to review the existing hydrologic study prepared for the Faria Preserve, revise existing hydrology as needed, and to complete a preliminary hydrologic analysis of the remaining area within the Northwest Specific Plan. This Master Plan Hydrology Report for the Northwest Specific Plan completes the hydrologic analysis for the planning area.

Kimley-Horn reviewed an unsigned and unsealed hydrology study report that was completed for the Faria Preserve by Bellecci and Associates in April 2003 titled "Hydrology Study, Lands of Faria." The Lands of Faria has since been segmented into the Faria Preserve and the Lands of Faria. The drainage basins delineated for existing and proposed conditions hydrologic analysis and the results presented in the Faria Preserve Hydrology, appear to be reasonable and were not refined as part of this Master Plan Hydrology Report.

Kimley-Horn conducted a site visit on August 19, 2004. From visual observation and judgment the grass in the open areas covered approximately 50 to 75%. Upon review the NRCS soils survey for Contra Costa County the soils within the NWSP area are classified as hydrologic soils groups B, C, and D. The curve numbers associated with these types of soils and land use conditions are different than the curve numbers used in the Faria Preserve Hydrology Study. Kimley Horn recreated the hydrologic models for drainage areas contributing to proposed detentions on the Faria Preserve.

Based on the reanalysis of the Faria Preserve hydrology, additional detention basin storage volume needs to be added within the Pond 1/Pond 2 watershed. This additional detention basin storage volume is needed to attenuate the proposed conditions peak discharge values to meet existing conditions peak discharge values. Further evaluation should be required prior to acceptance of the final drainage study for the Faria Preserve.

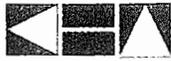
To remain consistent runoff calculations for drainage basins analyzed as part of this Master Plan Hydrology Report were determined using the methodologies consistent with the Faria Preserve Hydrology.

Drainage basins outside of the Faria Preserve were delineated as part of this Master Plan Hydrology Report. Drainage basins numbered 005 through 035 crossing the Chu property were delineated along existing ridge lines from the peak of the drainage basin area to the banks of the Bollinger Creek. Land use for the existing conditions hydrologic evaluation was classified as Open Space.

Proposed conditions hydrologic evaluation took into account the land use change based on the proposed lot layout for the Chu property by Donald L. Blayney and Associates. Land use classification was changed from Open Space to Residential based on the preliminary Lot Layout for The Chu property. A conservative estimation of the retention requirements using the preliminary lot layout would be to retain the volume associated with the difference in runoff volume between pre and post conditions runoff volume. This volume is 0.40 acre feet. For an example, a detention basin with a 70-ft. by 70-ft. bottom width and 4 to 1 side slopes would contain the entire 0.40 acre feet with less than 3 feet of ponding depth.



The stormwater detention basin/basins for the Chu property will need to be located and sized to collect the contributing runoff. This analysis will need to be refined as part of the development plans for the Chu property. Development for the Chu property will fall under the Hydrograph Modification Management Plan. Compliance with criteria set forth in the Hydrograph Modification Management Plan document is the responsibility of the Chu property developer.



5. REFERENCES

Bellecci and Associates, Inc, Hydrology Study: Lands of Faria, San Ramon, Contra Costa County, CA, April 28, 2003. (Unsealed and Unsigned).

“Northwest Specific Plan Project Description” Provided by Richard Loewke of Richard T. Loewke, Urban & Environmental Planning, in electronic format.

Faria Ranch, San Ramon, California, Planning Document dated June 3, 2003

Conceptual Biological Mitigation and Monitoring Plan for the Faria Ranch Project, San Ramon, Contra Costa county, California, Prepared by The Huffman-Broadway Group, Inc., dated August 2004.

Contra Costa Public Works Department, Precipitation Duration-Frequency-Depth Curves, Recurrence Interval 100 years, Drawing Number B-162.

Contra Costa Public Works Department, Mean Seasonal Isohyets compiled from Precipitation Records 1879-1973, Drawing Number B-166.

EDAW Exhibits: Development Suitability, Major Ridgelines, Slope Classification, and 100-yr Floodplain.

Chu Property, San Ramon, California, Proposed Lot Layout Prepared by Donald L. Blayney & Associates, dated April 27, 2004.

Work Plan and Literature Review for the Hydrograph Modification Management Plan, Contra Costa Clean Water Program, dated February 12, 2004.

HEC Hydrologic Modeling System (HEC-HMS) Version 2.2.2, May 28, 2003.

Technical Release 55 (TR-55) Urban Hydrology for Small Watersheds, United States Department of Agricultural, Soil Conservation Service, June 1986.

Natural Resources Conservation Service (NRCS) soils survey for Contra Costa County, electronic format from <http://soildatamart.nrcs.usda.gov/>.