Napa County
Updated Hydrogeologic Conceptualization and Characterization of Conditions (Part 1)

presentation for

by
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Consulting Engineers

and
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MBK Engineers

January 31, 2013
Review of Napa County Water Resources Goals

- **Goal CON-12**: Collect info about status of SW and GW resources to provide for improved forecasting of future supplies and effective management of the resources in each of the County’s watersheds.

- **Action Item CON WR-4**: Implement a countywide watershed monitoring program to assess the health of the County’s watersheds…

- **Action Item CON WR-8**: County shall monitor GW/SW interrelationships, using County-owned MWs and stream and precipitation gauges, data obtained from private property owners on a voluntary basis, data obtained via conditions of approval associated with discretionary projects, data from DWR and other agencies and organizations…
Napa Co. Comprehensive GW Monitoring Program

- Data Management System (DMS)  
  [Task 1 TM]
- Evaluation of Data  
  [Task 2 TM]
- Evaluation of County GW Model  
  [Task 3.2 TM]
- Guidance on Precipitation & Streamflow Monitoring  
  [Task 3.3 TM]
- Napa County GW Conditions  
  [Task 4, Report]
- GW Planning Considerations & Ordinance & Permit Process  
  [Task 5 TM]
- Executive Summary

Available on Napa County web site at:  
http://www.countyofnapa.org/bos/grac
Study Recommendations & Data Gaps

Broad Criteria Identifying Countywide Monitoring Needs

- Some Subareas sparse Level and/or Quality data (and/or lack of info related to measured well)
- Subareas where population/ag or other GW demands are relatively greater
- Improved overall spatial (horizontal and vertical) distribution
- Improve understanding of SW/GW interrelationships
GW Levels: Priority Subareas
- NVF-Calistoga
- NVF-St. Helena
- NVF-Yountville
- NVF-Napa
- NVF-MST
- Carneros
GW Quality: Priority Subareas

- NVF-MST
- Carneros
- Jameson/American Canyon
Updated Conceptualization & Characterization of Hydrogeologic Conditions in Napa County

Project Overview/Work by LSCE & MBK

Task 1: Updated hydrogeologic conceptualization and characterization for priority areas

Task 2: ID supplemental GW monitoring wells for high priority areas

Task 3: Refine and further characterize areas with greatest recharge potential

Task 4: Guidance for CEQA-related issues and analysis of SW/GW interactions
Updated Hydrogeologic Conceptualization

• Part 1
  • Overview of Report
  • Groundwater Recharge
  • SW/GW Interactions

• Part 2
  • Regional Geology
  • Surficial, Structural, & Subsurface Geology
  • Hydrogeology
Groundwater Balance

**Inflows**
- Precipitation;
- SW inflow & infiltration;
- Intentional recharge (ponds, ditches, etc.);
- Applied water, net recharge (e.g., irrigation);
- Unintentional recharge (leaky pipelines);
- Subsurface inflows from outside basin.

**Outflows**
- GW extraction by wells;
- GW discharge to SW/springs;
- Evapotranspiration; and
- Subsurface outflow from basin.

Inflows – Outflows = △ $S$

*Change in GW Storage*

Modified from USGS Circular 1308
GW Recharge Analysis Overview

- Estimate recharge in Napa County with a focus on the Napa Valley floor
- Analysis based on actual data
  - Use a model to understand the physical processes
- Draw conclusions related to how recharge may vary
  - Spatially
  - Temporally
- Test model sensitivity to inputs to understand uncertainty
Analytical Approach

- Mass-balance of soil root-zone
- Based on DWR Integrated Water Flow Model Demand Calculator (IDC)
- Analysis done at monthly time-step to estimate annual recharge
Root-Zone Water Balance Model

- **P** = Precipitation
- **R** = Runoff
- **P-R** = Infiltration
- **ET** = Evapotranspiration
- **θ** = Soil moisture storage
- **D** = Deep percolation

Water balance equation:

$$\theta_t = \theta_{t-1} + P_t - R_t - ET_t - D_t$$

- Applied at the watershed level
  - Runoff = gaged outflow
  - Deep percolation = GW recharge
Precipitation Gages

- Available data:
  - Point gages
  - Limited periods of record

- Need:
  - Spatial distribution
  - Long time-series of monthly values
Precipitation – PRISM

- Oregon State University Parameter-elevation Regressions on Independent Slopes Model (PRISM)
- 800 m grid cells
- 1971 to 2000 monthly normal precipitation
- Monthly normals used to scale Napa State Hospital record
Flow Gages

- Outflow or runoff
- 9 gaged watersheds
  - Napa River at
    - Calistoga
    - St. Helena
  - Napa
  - Conn Creek
  - Dry Creek
  - Redwood Creek
  - Napa Creek
  - Milliken Creek
  - Tulucay Creek
## Flow Gage Records

<table>
<thead>
<tr>
<th>Streamflow Gage Name</th>
<th>USGS Gage #</th>
<th>Start Year</th>
<th>End Year</th>
<th>Number of Years</th>
<th>Watershed Size (mi²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Napa River near Napa</td>
<td>11458000</td>
<td>1960</td>
<td>2011</td>
<td>52</td>
<td>218</td>
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<tr>
<td>- Conn Creek near Oakville</td>
<td>11456500</td>
<td>1930</td>
<td>1959</td>
<td>30</td>
<td>55.4</td>
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<td></td>
<td></td>
<td>1971</td>
<td>1975</td>
<td>5</td>
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<tr>
<td>- Dry Creek near Napa</td>
<td>11457000</td>
<td>1952</td>
<td>1966</td>
<td>15</td>
<td>17.4</td>
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<tr>
<td>- Napa River near St Helena</td>
<td>11456000</td>
<td>1940</td>
<td>1995</td>
<td>56</td>
<td>78.8</td>
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<tr>
<td></td>
<td></td>
<td>2001</td>
<td>2011</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>-- Napa River at Calistoga</td>
<td>11455900</td>
<td>1976</td>
<td>1983</td>
<td>8</td>
<td>21.9</td>
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<tr>
<td>Milliken Creek near Napa</td>
<td>11458100</td>
<td>1971</td>
<td>1983</td>
<td>13</td>
<td>17.3</td>
</tr>
<tr>
<td>Tulucay Creek at Napa</td>
<td>11458350</td>
<td>1972</td>
<td>1983</td>
<td>12</td>
<td>12.6</td>
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<td>Napa Creek at Napa</td>
<td>11458300</td>
<td>1971</td>
<td>1983</td>
<td>13</td>
<td>14.9</td>
</tr>
<tr>
<td>- Redwood Creek near Napa</td>
<td>11458200</td>
<td>1959</td>
<td>1973</td>
<td>15</td>
<td>9.8</td>
</tr>
</tbody>
</table>
Infiltration

- Infiltration calculated as:
  - Infiltration = Precipitation – Outflow

- Infiltration enters the root-zone and becomes soil moisture
  - Available for evapotranspiration
  - Excess can become recharge
Evapotranspiration

- Potential evapotranspiration (PET) developed from CIMIS\(^1\) \(E_{T_0}\) and ITRC\(^2\) Report, Zone 8 data
- ET is a function of available soil-moisture
  - Plant water stress reduces PET to ET
- Vineyard ET subject to deficit irrigation

\(^1\)California Irrigation Management Irrigation System
\(^2\)Irrigation Training and Research Center – California State University, San Luis Obispo
Evapotranspiration – Land Use

- ET is determined based on type of vegetation
- Vegetation determined from land use data
- Land use data from DWR and NRCS
- Ten different land use categories
  - Native: forest, shrubland, grassland, wetland, and water
  - Ag: vineyards, other crops, idle
  - Urban
DWR 1999 Survey

NRCS 2007 Imagery
Deep Percolation (Recharge)

- Three methods analyzed:
  - Van Genuchten Mualem (VGM) method
  - Campbell’s Model
  - Percent over field capacity

- Recharge is a function of soil parameters
  - NRCS database used to estimate soil parameters

- No significant difference in results between methods
Root-Zone Water Balance Model Inputs

- Precipitation developed from PRISM and Napa State Hospital gage
- Runoff from USGS streamflow gages
- ET from CIMIS
  - Varies by land use
  - Function of available water
- Recharge calculated as function of soil parameters
- Soil moisture storage calculated from water balance
Results

- Monthly analysis summarized to annual results
- Results by gaged watershed
Dry Creek

[Bar chart and graph displaying volume (acre-feet) over time from 1952 to 1966, with categories for Change in Soil Storage, Recharge, Outflow, ET, and Precipitation.]

<table>
<thead>
<tr>
<th>Year</th>
<th>Change in Soil Storage</th>
<th>Recharge</th>
<th>Outflow</th>
<th>ET</th>
<th>Precipitation</th>
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<tbody>
<tr>
<td>1952</td>
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<td>1966</td>
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</table>
## Water Budget Summary for Available Periods

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Precip. (acre-feet)</th>
<th>Outflow (acre-feet)</th>
<th>Infilt. (acre-feet)</th>
<th>ET (acre-feet)</th>
<th>Recharge (acre-feet)</th>
<th>Range (acre-feet)</th>
<th>Recharge (% of Precip.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Napa River near Napa</strong></td>
<td>418,500</td>
<td>146,800</td>
<td>271,700</td>
<td>201,900</td>
<td>70,600</td>
<td>8,300 - 185,900</td>
<td>17%</td>
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<tr>
<td>- <strong>Conn Creek</strong></td>
<td>98,200</td>
<td>24,600</td>
<td>73,600</td>
<td>52,200</td>
<td>21,100</td>
<td>4,300 - 40,700</td>
<td>21%</td>
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<tr>
<td>- <strong>Dry Creek</strong></td>
<td>33,000</td>
<td>14,200</td>
<td>18,700</td>
<td>16,400</td>
<td>2,000</td>
<td>500 - 6,300</td>
<td>6%</td>
</tr>
<tr>
<td>- <strong>Napa River at St. Helena</strong></td>
<td>161,400</td>
<td>67,000</td>
<td>94,400</td>
<td>72,500</td>
<td>22,000</td>
<td>2,500 - 60,900</td>
<td>14%</td>
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<tr>
<td>-- <strong>Napa River at Calistoga</strong></td>
<td>54,200</td>
<td>23,600</td>
<td>30,600</td>
<td>19,700</td>
<td>10,500</td>
<td>2,000 - 17,200</td>
<td>19%</td>
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<tr>
<td><strong>Milliken Creek</strong></td>
<td>33,000</td>
<td>16,800</td>
<td>16,200</td>
<td>13,500</td>
<td>2,500</td>
<td>100 - 7,100</td>
<td>8%</td>
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<tr>
<td><strong>Tuluucay Creek</strong></td>
<td>19,500</td>
<td>9,100</td>
<td>10,400</td>
<td>9,500</td>
<td>1,000</td>
<td>100 - 2,300</td>
<td>5%</td>
</tr>
<tr>
<td><strong>Napa Creek at Napa</strong></td>
<td>32,100</td>
<td>14,800</td>
<td>17,300</td>
<td>13,700</td>
<td>3,600</td>
<td>600 - 6,900</td>
<td>11%</td>
</tr>
<tr>
<td>- <strong>Redwood Creek</strong></td>
<td>19,300</td>
<td>7,800</td>
<td>11,500</td>
<td>9,500</td>
<td>1,900</td>
<td>400 - 5,000</td>
<td>10%</td>
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<tr>
<td>Watershed</td>
<td>Average Annual Precipitation (feet)</td>
<td>Average Annual Recharge (feet)</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Napa River near Napa</td>
<td>--</td>
<td>2.51</td>
<td>3.42</td>
<td>--</td>
<td>0.37</td>
<td>0.68</td>
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<tr>
<td>- Conn Creek</td>
<td>2.91</td>
<td>--</td>
<td>--</td>
<td>0.74*</td>
<td>--</td>
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<tr>
<td>- Dry Creek</td>
<td>3.19</td>
<td>2.65</td>
<td>--</td>
<td>0.12</td>
<td>0.24</td>
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<tr>
<td>- Napa River at St. Helena</td>
<td>3.25</td>
<td>2.70</td>
<td>3.73</td>
<td>0.28</td>
<td>0.31</td>
<td>0.68</td>
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</tr>
<tr>
<td>-- Napa River at Calistoga</td>
<td>--</td>
<td>--</td>
<td>3.89</td>
<td>--</td>
<td>--</td>
<td>0.76</td>
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<tr>
<td>Milliken Creek</td>
<td>--</td>
<td>--</td>
<td>3.14</td>
<td>--</td>
<td>--</td>
<td>0.31</td>
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<tr>
<td>Tulucay Creek</td>
<td>--</td>
<td>--</td>
<td>2.53</td>
<td>--</td>
<td>--</td>
<td>0.11</td>
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<tr>
<td>Napa Creek at Napa</td>
<td>--</td>
<td>--</td>
<td>3.44</td>
<td>--</td>
<td>--</td>
<td>0.39</td>
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<tr>
<td>- Redwood Creek</td>
<td>--</td>
<td>2.71</td>
<td>--</td>
<td>--</td>
<td>0.33</td>
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<td></td>
</tr>
</tbody>
</table>

*Not adjusted for storage in Lake Hennessey*
Figure 6-2 Geologic Units of Greatest Recharge Potential
# Areas of Greatest Potential Recharge

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Area (acres)</th>
<th>Area of Units of Greatest Potential Recharge(^1) (acres)</th>
<th>Percent of Watershed</th>
<th>Recharge (% of Precip.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Napa River near Napa</td>
<td>139,819</td>
<td>59,809</td>
<td>43%</td>
<td>17%</td>
</tr>
<tr>
<td>- Conn Creek</td>
<td>35,501</td>
<td>8,338</td>
<td>23%</td>
<td>21%</td>
</tr>
<tr>
<td>- Dry Creek</td>
<td>11,155</td>
<td>288</td>
<td>3%</td>
<td>6%</td>
</tr>
<tr>
<td>- Napa River at St. Helena</td>
<td>50,984</td>
<td>28,321</td>
<td>56%</td>
<td>14%</td>
</tr>
<tr>
<td>-- Napa River at Calistoga</td>
<td>13,937</td>
<td>5,867</td>
<td>42%</td>
<td>19%</td>
</tr>
<tr>
<td>Milliken Creek</td>
<td>11,112</td>
<td>2,947</td>
<td>27%</td>
<td>8%</td>
</tr>
<tr>
<td>Tulucay Creek</td>
<td>8,052</td>
<td>3,886</td>
<td>48%</td>
<td>5%</td>
</tr>
<tr>
<td>Napa Creek at Napa</td>
<td>9,886</td>
<td>2,802</td>
<td>28%</td>
<td>11%</td>
</tr>
<tr>
<td>- Redwood Creek</td>
<td>6,434</td>
<td>1,224</td>
<td>19%</td>
<td>10%</td>
</tr>
</tbody>
</table>

\(^1\)LSCE Napa County Conditions and Groundwater Monitoring Recommendation, 2011
Recharge Observations

- Recharge can vary significantly from year to year
- More recharge in northern portion of the Valley
  - Generally more precipitation
- Tuluca Creek and Dry Creek watershed have lower recharge
  - Tuluca Creek has highest percent urban land use
  - Dry Creek has low percent of areas of greatest potential recharge
Sensitivity Analysis

- Analyzed:
  - Root depth
  - Soil parameters (field capacity, porosity, pore-size distribution)
  - ET of native forest
  - Order of mass balance calculation

- Results most sensitive to root depth and ET of native forests

- Recharge results are likely within +/- 20 percent
  - Uncertainty in several model inputs affects results
Future Consideration

- Further research on water use by native vegetation
- Analysis of ungaged watersheds
  - Rainfall-runoff or other methods to estimate outflow
  - More detailed analysis on spatial variability
- Putah Creek watershed
Updated Hydrogeologic Conceptualization and Evaluation of SW/GW Interactions
GW Monitoring in High Priority Subareas

Key GW Level Objective

Further evaluate SW-GW interaction

Direct Connection
Maintains/Recharges Stream

Indirect Connection
Stream Seepage Independent of GW Levels

Courtesy TNC
Napa River and Tributaries

Estimated Stream Thalweg Mapping
Estimated Stream Thalweg Elevations

- Developed from LiDAR\(^1\) data and digitized stream alignments
- Compared with USGS maps and surveyed data on Napa River
- Results are consistent with topography and surveyed data

\(^1\) LiDAR (Light Detection And Ranging)
Comparison of Estimated Stream Thalweg Elevation with Surveyed Data
Groundwater Elevations
Monitored Wells and LiDAR Derived Depth to GW

Monitored Site (Depth to Water, feet)
- Sites with Unknown Aquifer Completion
- Sites with Limited Construction Info
- Sites with Aquifer-Specific Construction Info

LiDAR-Derived Depth to Groundwater, feet
- 0.0 - 10
- 10.01 - 20
- 20.01 - 30
- 30.01 - 40
- 40.01 - 250

Napa River
Subarea Boundary
County Boundary

0 1 2 Miles
N

42
Focus on NE Napa Subarea/MST
From Task 2 – NVF Napa: Comparing WL Data and Well Construction

- Sites with Recent (post 2005) water level data and construction info
- Sites with Historical (pre 2005) water level data and construction info
- Sites with water level data and no construction info
**06N/04W-27L2**  
Perforated Interval = 60' - 120'  
Source: DWR  
RPE: 51', msl

**NapaCounty-75**  
Perforated Interval = 45'-205'  
Source: Napa County  
RPE: 38.5', msl

**T0605500044 MW-16**  
Perforated Interval = 42' - 47'  
Source: GeoTracker  
RPE: 47.05', msl
GW Monitoring: Recommended Areas of Interest (AOIs)

- 18 additional areas proposed for GW level & quality monitoring
- 6 additional areas proposed for evaluation of SW/GW interaction
Updated Hydrogeologic Conceptualization

- Part 1 (January 31)
  - Overview of Report
  - Groundwater Recharge
  - SW/GW Interactions

- Part 2 (February 28)
  - Regional Geology
  - Surficial, Structural, & Subsurface Geology
  - Hydrogeology
Thank You

Discussion & Questions