

**From: Chris Berry - County of Santa Cruz Water Advisory Commissioner/City of Santa Cruz Water Department**

**To: County of Santa Cruz Water Advisory Commission**

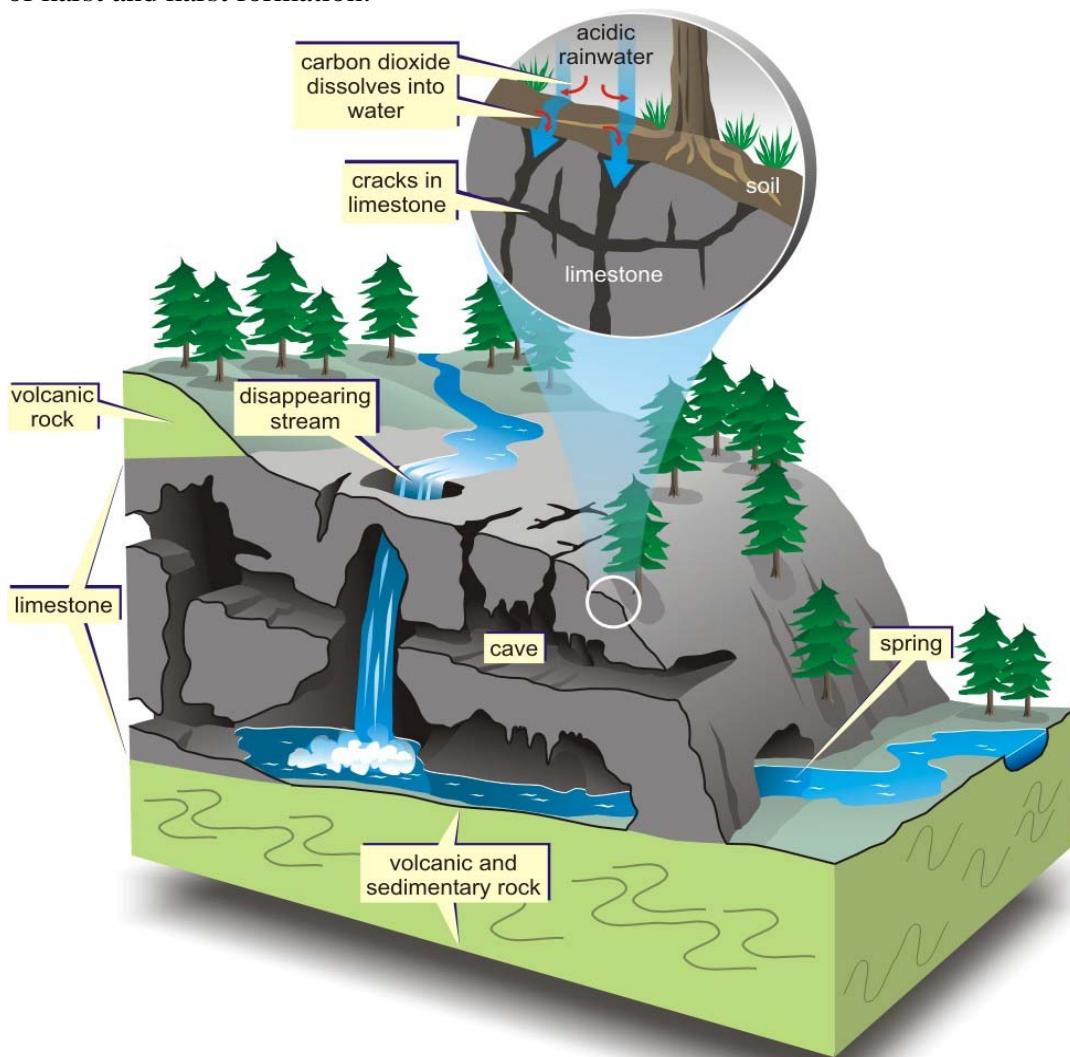
**Date: March 25, 2010 (for the April 8, 2010) agenda**

**RE: Karst Protection Planning**

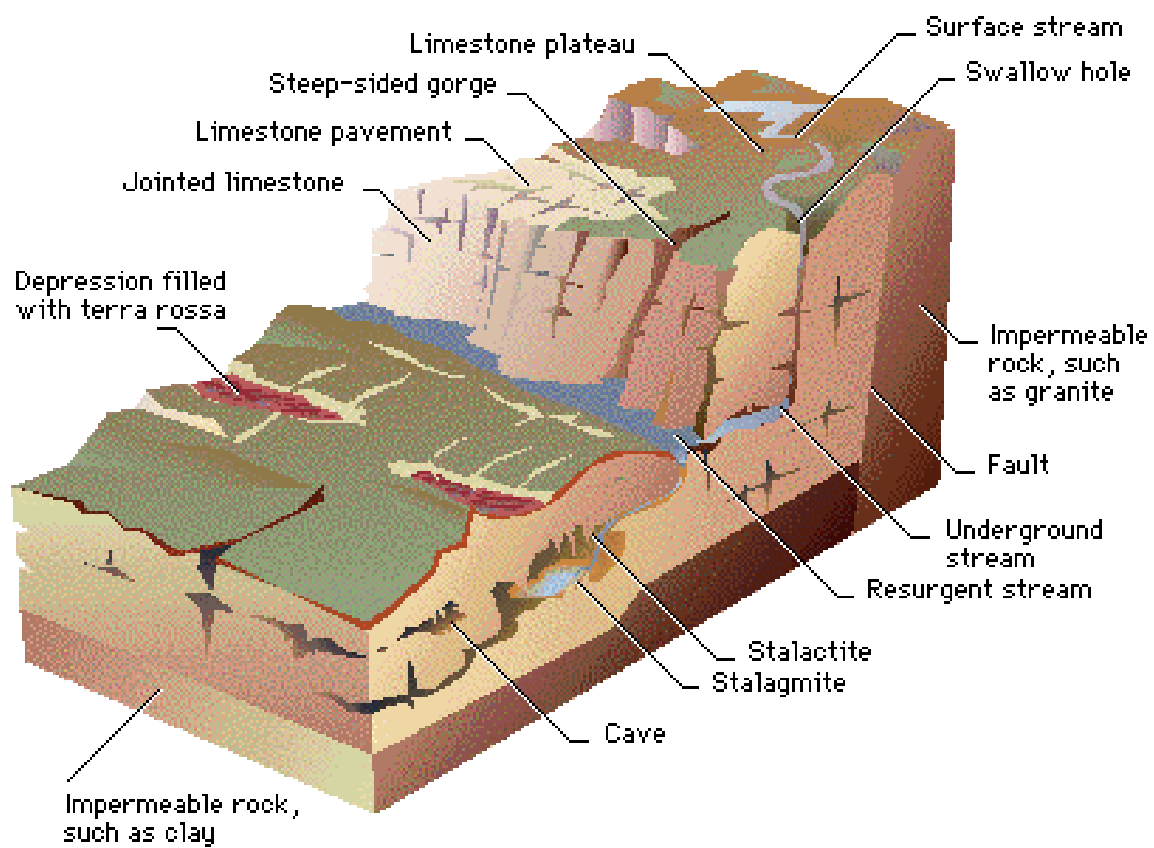
## Karst Protection Zone Policy Development for Santa Cruz County

### *Background:*

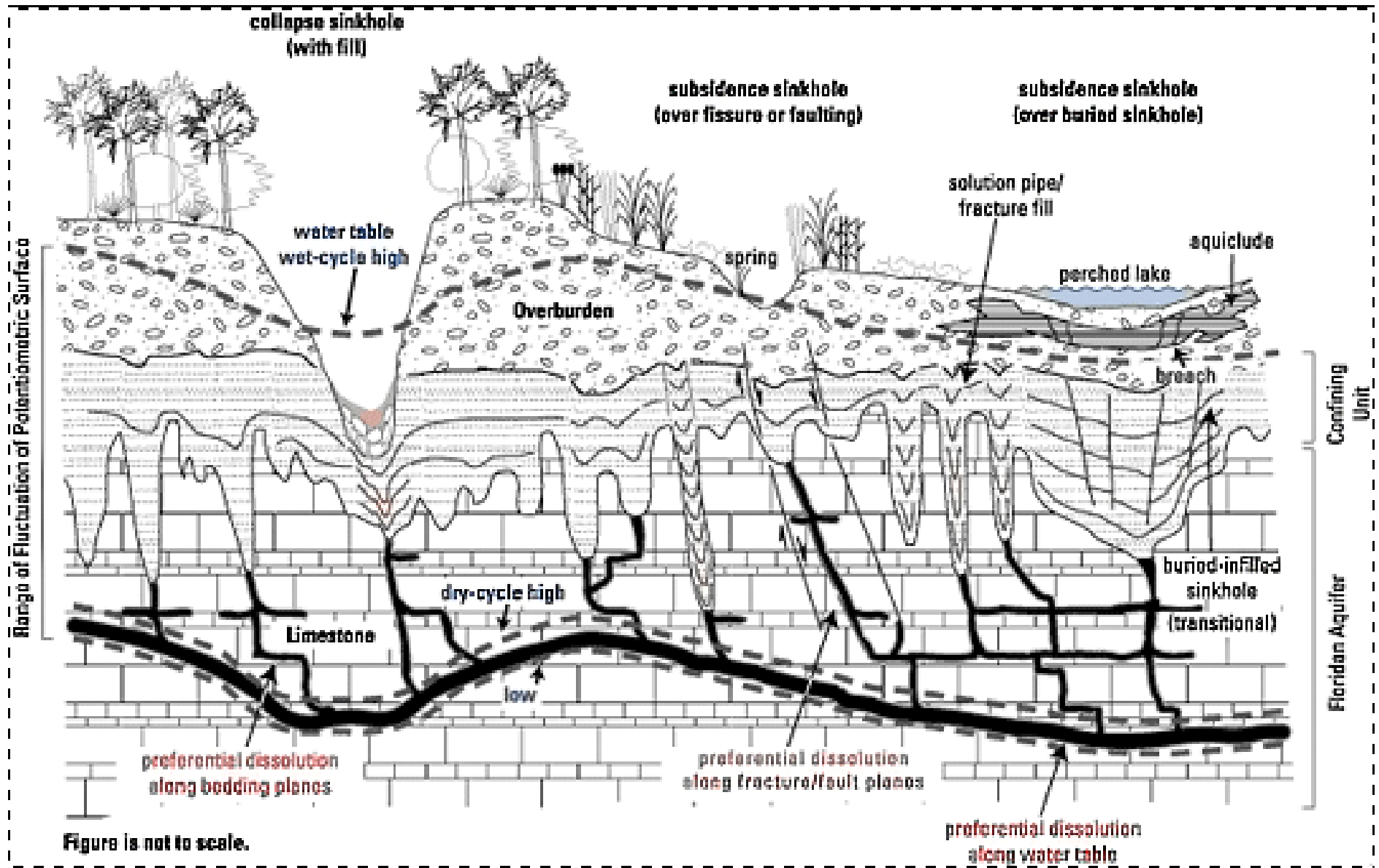
Karst is best described as a region characterized by sinkholes, underground streams, and caverns. These underground conduits are typically formed by acidic rain water dissolving certain types of soluble bedrock over thousands to millions of years. Karst areas are typically devoid of surface water as all the water is diverted through underground channels. The main theme in karst regions is underground drainage. Twenty percent of the land in the United States is classified as karst. Karst is found throughout the US and the look varies from region to region. Examples of karst include the huge clear springs of Florida, the large and decorated caves of New Mexico, and the sinkhole plains of Kentucky...and Bonny Doon, California. The following images below demonstrate basic features of karst and karst formation:



From: Vancouver Island University  
<http://web.viu.ca/geoscape/Karst.htm>



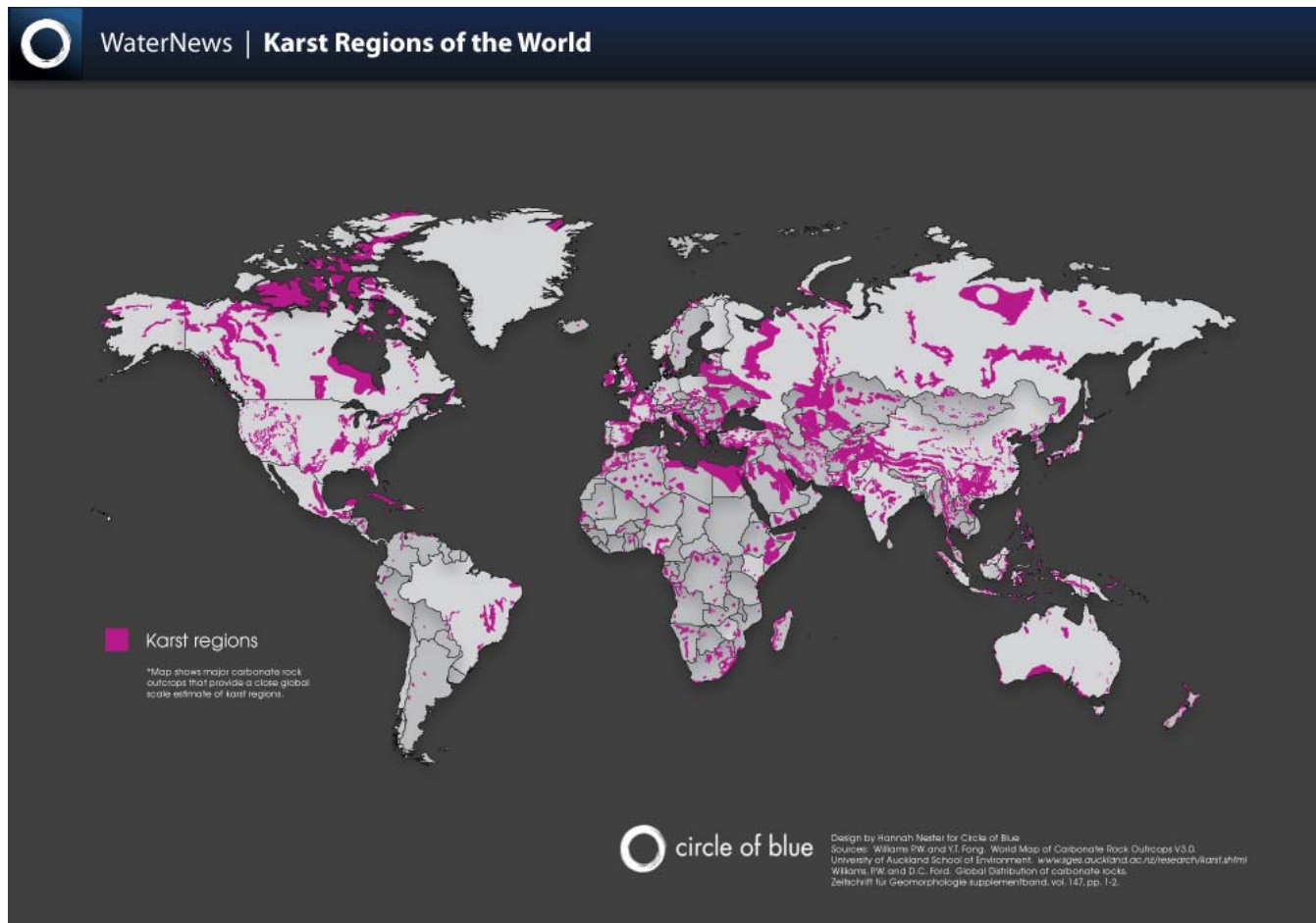
From: UNESCO Global Geo Parks Network  
<http://www.globalgeopark.org/publish/portal1/tab226/info2213.htm>



From: USGS - Engineering Aspects of Karst (Adapted from Davies, W.E., Simpson, J.H., Ohlmacher, G.C., Kirk, W.S., and Newton, E.G., 1984)

[http://rnp782.er.usgs.gov/atlas2/articles/geology/a\\_karst.html](http://rnp782.er.usgs.gov/atlas2/articles/geology/a_karst.html)

25% of the nation's drinking water comes from karst aquifers. Karst regions contain some of the largest and most productive aquifers that are capable of providing large supplies of water. On the downside, surface water in karst areas flows into caves and sinkholes very quickly, receiving very little filtration. This water, and the impurities it carries - human and animal waste, pesticides, fertilizers, petroleum products, and other pollutants - often travel great distances underground, contaminating wells, springs, and aquifers (The Karst Conservancy 2008).



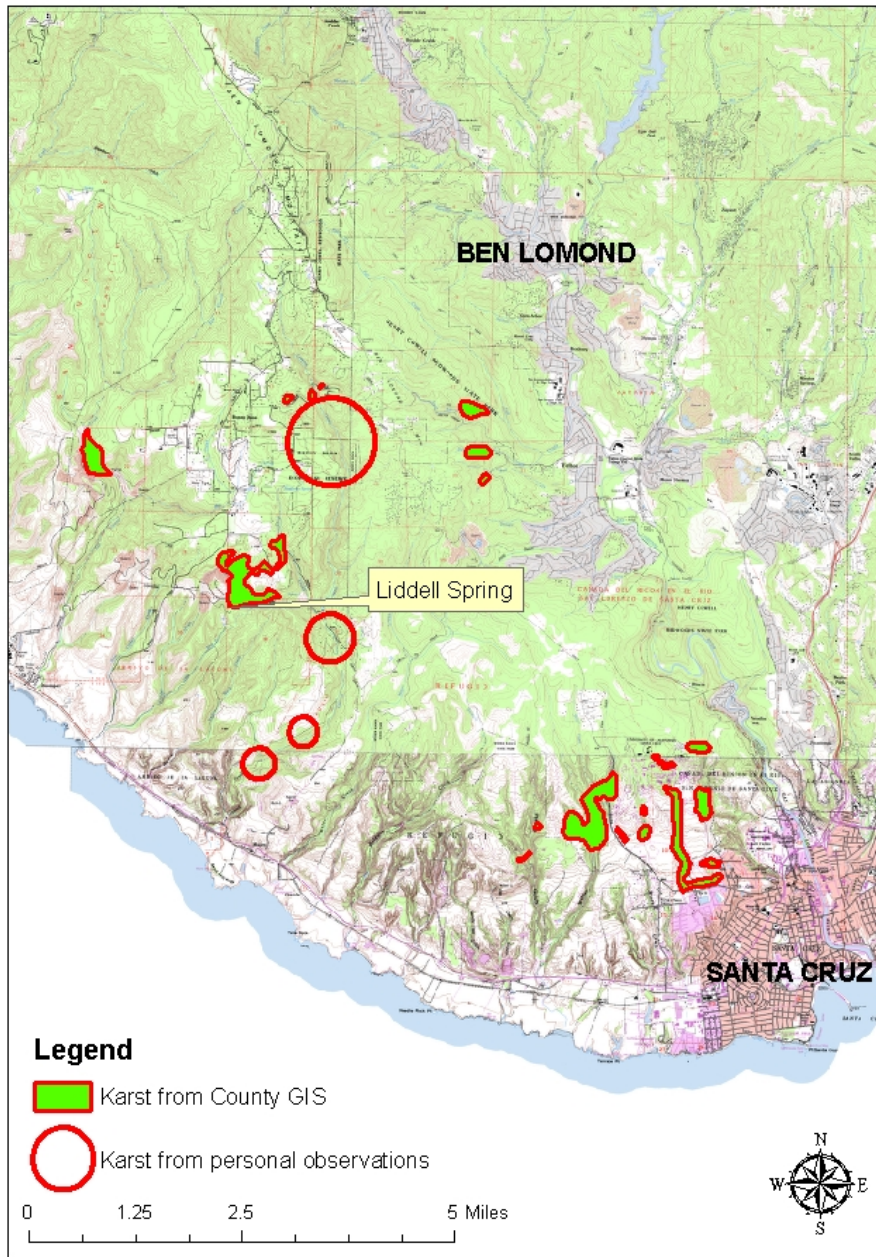
From: Circle of Blue Water News

<http://www.circleofblue.org/waternews/wp-content/uploads/2010/01/world-karst-map-web-1.12.jpg>

Karst is known to occur in several areas of Santa Cruz County; primarily in Bonny Doon, Felton and the southeastern end of Ben Lomond Mountain in the vicinity of Pogonip and UCSC. It should be noted, that surface expressions of karst are easily identifiable and usually have historic mining activity associated with them. However, in cases where karst is not visible on the surface or no historical mining has occurred in the vicinity – as in the case of some remote areas in the Laguna Creek watershed – karst may not necessarily be mapped in the County’s geologic database. The figure below illustrates some known karst locations:

# Karst map of SC Co<sup>1</sup>

## Countywide Known Karst



<sup>1</sup> Note that there are likely areas of karst in the County which aren't mapped. These may not have surface features or are in relatively remote areas of the County, such as the areas on Laguna Creek which are identified by red circles.

Unlike aquifers with relatively more regular porosity, transmissivity and hydraulic conductivity commonly found in the County, karst aquifers (such as that found in Bonny Doon in the San Vicente/Laguna and Liddell Creek headwaters) are substantially more likely to have extreme seasonal groundwater elevation changes - for example, monitoring wells in the vicinity of the proposed expansion area of the Bonny Doon Quarry exhibited elevations varying as much as 150 ft from wet to dry periods during the limited period of the PELA quarry expansion – related hydrogeologic study (PELA 2005) – thereby resulting in “communication” between phreatic and vadose (vadose water being more likely to be polluted by potentially contaminating activities (PCAs), and more subject to changes in flow paths due to dissolution/collapse of karst features (i.e. karrens, sinkholes, sinking streams, springs, caverns, etc.). As an aside, groundwater in karst, is often characterized by flow patterns which are tantamount to underground rivers (Dr. Barry Beck – personal communication 2007) – thereby potentially making it subject to California water law and water rights conventions (Katz 2007).

Therefore, it is obvious that protection of karst cannot be based on the same criteria as non-karstic aquifers where groundwater circulation more closely obeys Darcy’s law. Also, because of specificity and hydrogeological particularity of the recharge zone in karst – which are more emphatic than in nonkarstic terrane – it is clear that an application of strictly formulated regulations is not possible (Milanovic 2004). The Santa Cruz County Water Advisory Commission (WAC) has struggled for several years in determining the best role for itself in protecting water resources in karstic areas of the County. Given the recent determination that the WAC is not authorized to comment on specific proposals (specifically, permit applications) (Garcia 2009) which might effect karstic groundwater basins (karst) - but that it should more appropriately recommend policy to the Board of Supervisors (BOS) - the WAC determined to initiate recommendations for development of “karst protection zone(s)” (KPZ) for areas of the County where the particular complexity and relatively unconfined nature of karstic groundwater basins may render associated water resources more vulnerable to effects of PCAs.

#### *Karst Conservation Planning General:*

Many other states and countries around the world have specific planning regulations which are oriented toward protection of karst – both for the associated water resources, as well as for the (often unique) flora and fauna<sup>2</sup> which inhabit the karst features of such a geologic formation.

Generally speaking, most karst protection policies involve some elements of restricting development around a karst feature by establishing a fixed radius or delineated area around the feature. This strategy helps both to reduce non-point source pollution by maintaining vegetation and tree cover and to reduce the risk of subsidence and sinkhole flooding. Some communities establish varying buffer requirements based on specific karst features and the relative hazard risk associated



*Empire Cave Pseudoscorpion Photo: J Ledford*

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<sup>2</sup> Though it is not the primary focus of this memo, several species are unique to karst systems. Among them are the Doloff Cave Spider and Empire Cave Pseudoscorpion. Many species endemic to karst systems have likely yet to be identified. Finally, cool, persistent karst groundwater flow has recently been identified as being especially crucial in federal coho salmon recovery planning – due to its relatively greater benefit to anadromous fish habitat during the relatively hot, low flow periods of the year and during drought periods. (NMFS 2010)

with them. For example, in some European countries examples of such buffer zones include protection zones of varying immediacy:

- Zone 1: Immediate protection of a drinking water intake (10-50m from an intake)
- Zone 2: Protection area (area outside zone 1 with active swallow holes, high transmissive zones, etc.)
- Zone 3: External protection area (no direct connection to the highly transmissive zones, travel time to the intake is >50 days, rocks aren't strongly karstified and underground flow rates are < 1 cm/s).

To minimize the public health risk in some countries (e.g. The Netherlands), delay of groundwater in the aquifer of at least 10 years is needed with results both 10 and 25 year protection zones – referred to as the “karst protection area”. (Milanovic 2004)

Performance Standards and restrictions for karst protection zones may include (Belo 2003), (State of Indiana 2007), etc.:

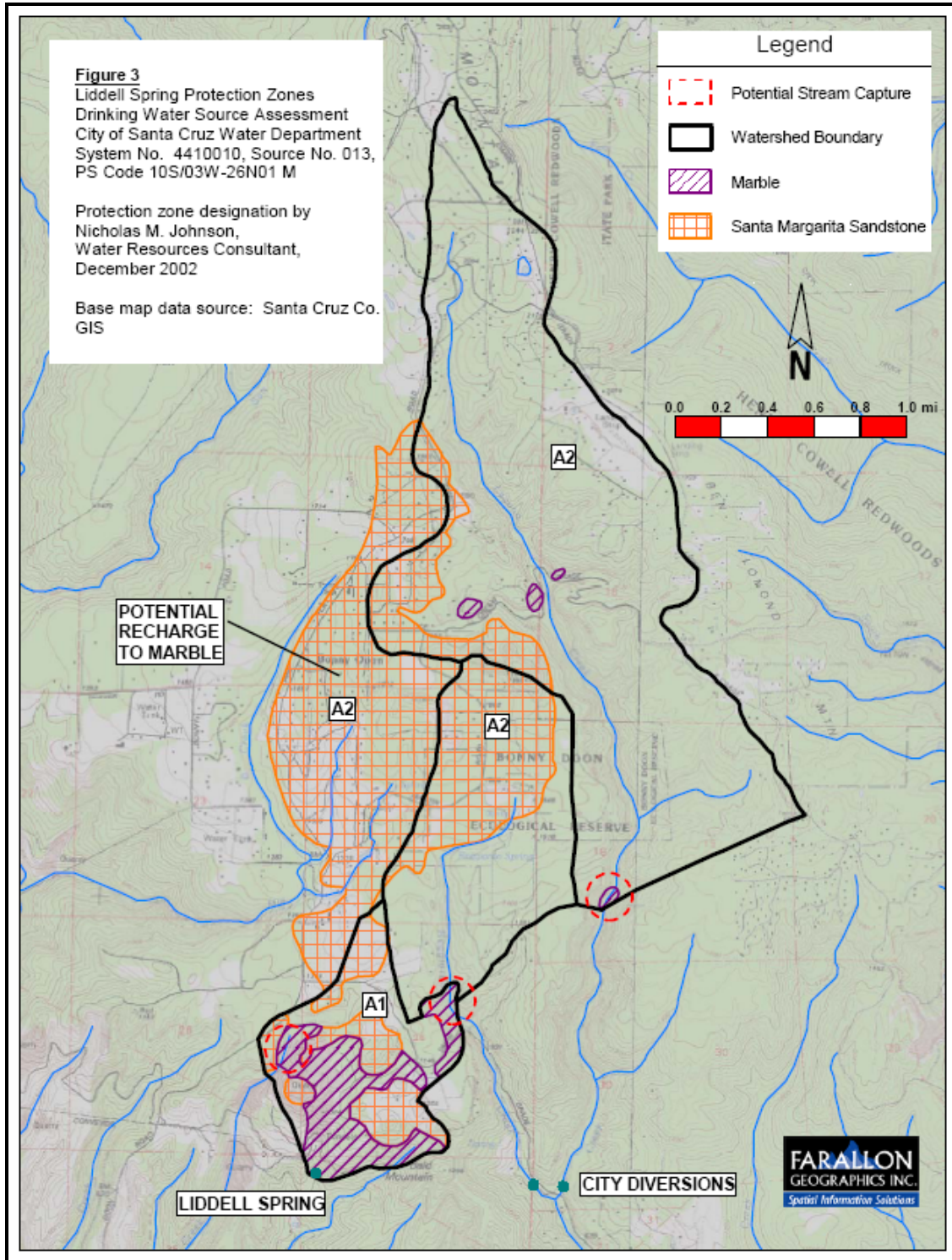
- Generally - maintaining predevelopment stormwater runoff quantity and quality.
- Relatively stricter effluent standards for septic systems
- Maintenance of pre-development recharge and discharge
- New development only when supported by adequate hydrogeological and geotechnical studies
- Protection of wellheads and springs.

This approach overlaps well conceptually with the DWSAP process - overseen by the California Department of Public Health (CA DPH) - which was developed to ensure “multi-barrier” protection of drinking water sources. The zones identified during the 2002 DWSAP (Johnson 2002) for Liddell Spring (as shown on the following page) were developed well before the more current hydrogeologic characterization of the recharge zone (Nolan and Johnson 2007)<sup>3</sup> and therefore may not be entirely inclusive of the Liddell Spring recharge area. However they do provide a useful example of how protection zones might be applied to protect this important water source in the future. They also illustrate how important rigorous hydrogeologic characterization is in the process of developing karst protection policies.

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<sup>3</sup> Figure of which follows the Liddell Spring DWSAP figure.

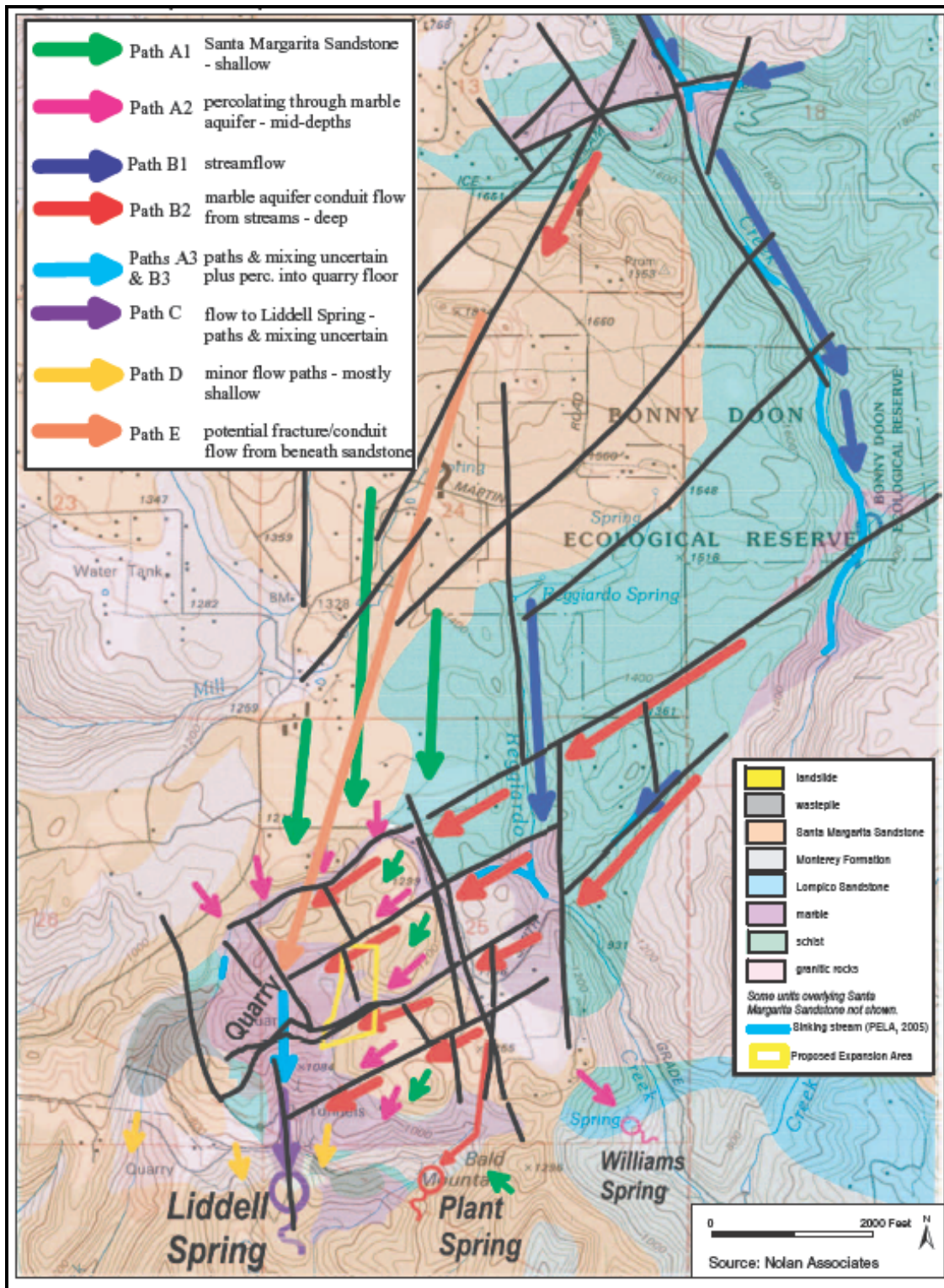
# Liddell Spring Protection Zones from the City of Santa Cruz DWSAP<sup>4</sup>



For more information on the California DWSAP process see:  
<http://www.cdph.ca.gov/certlic/drinkingwater/Pages/DWSAP.aspx>

<sup>4</sup> Note that protection zones may necessarily include non-karst areas which provide recharge to the karst.

Principle Groundwater Flow Paths (from Nolan and Johnson 2007)<sup>5</sup>



<sup>5</sup> Note that even this refined depiction of groundwater flow paths ends peremptorily on the eastern border due to monitoring and mapping limitations.

*Existing Policies and Regulations:*

A number of County codes and General Plan policies currently address water resource protection either directly or indirectly:

Water Supply Watershed General Plan Designation -

Generally provides several mechanisms for protection of water resources in a designated drainage basin. Requires uses in Water Supply Watershed and Least Disturbed areas to be compatible with watershed protection policies and limited to open space uses or recreational and residential uses at the specified Watershed densities, unless otherwise exempted and has several mechanisms for mitigating such land uses (minimum lot size, retention of stormwater, etc.). (Chapter 5.5)

Mining Regulations -

The Board of Supervisors hereby finds that extraction of minerals is important to the continued economic well being of the County and to the needs of society. The regulation and reclamation of mined lands is necessary to prevent or minimize adverse effects on the environment and to protect the public health and safety. The purpose of this Chapter is to regulate mining operations pursuant to standards provided herein or in other applicable law so as to:

- (a) Recognize the importance of the conservation of lands containing significant mineral resources for future mineral development. Any use of lands containing significant mineral resources shall reserve the future option of extraction of minerals in conformance with the policies established in the County's General Plan, Chapter 5.
- (b) Eliminate residual hazards so as to protect the public and adjacent properties from health and safety hazards and other adverse effects.
- (c) Protect water resources from adverse effects which might result from unregulated mining operations.
- (d) Prevent or minimize adverse environmental effects and require that mined lands are reclaimed to a usable condition which is readily adaptable for alternative land uses and implement the policies of the State of California Public Resources Code Section 2710, et seq., commonly known as the Surface Mining and Reclamation Act of 1975, as required by Section 2774(a) thereof.
- (e) Encourage the conservation and production of minerals while giving consideration to values relating to recreation, watersheds, wildlife, range and forage, and aesthetic enjoyment.
- (f) Provide for the reclamation of the land concurrently with mining operations.

- (g) Provide consistent performance standards applicable to all mining operations.
- (h) Identify and give public notice of any public hearing on any application for a Mining Approval, Certificate of Compliance, Reclamation Plan Approval or Mining Operation Review pursuant to Section 16.54.024.
- (i) Implement the policies of the General Plan and Local Coastal Program Land Use Plan.
- (j) Provide for compliance with regulations adopted by the State Board of Mining and Geology, including, but not limited to, Title 14, California Code of Regulations, Section 3500 and following.

The mining ordinance has a number of mechanisms for limiting impacts to water resources, among them are the depth to groundwater restriction in the mining code (code § 16.54.050)

#### Sewage Disposal -

The board of supervisors finds that the growth of the county has given rise to problems in the field of sanitation. The board finds that an orderly means of preventing environmental degradation and unsanitary conditions from occurring in wide areas of the county must be established, and that a safe and sanitary means of sewage disposal must be provided in connection with any new development or expansion of existing development. The board finds that comprehensive regulations are required for the control of individual sewage disposal facilities in the county, adequately to protect the public health, safety and welfare of the inhabitants thereof, and to implement the general plan and Local Coastal District Program Land Use Plan. Therefore, in order to protect the public health, safety and welfare, the board of supervisors of the county of Santa Cruz hereby adopts the provisions of this chapter relating to sewage disposal. Similar to the mining ordinance, the sewage disposal ordinance has several provisions for protection of water resources, primarily through separation from groundwater, required stream setbacks, treatment standards, etc. (code § 7.38)

#### Water Quality -

This ordinance generally mirrors the language of the Region 3 RWQCB Basin Plan for protection of beneficial uses of water from pollution (code §16.24)

#### Riparian Corridor and Wetlands Protection -

The purpose of this chapter is to eliminate or minimize any development activities in the riparian corridor in order to preserve, protect, and restore riparian corridors for: protection of wildlife habitat; protection of water quality; protection of aquatic habitat; protection of open space, cultural, historical, archeological and paleontological, and aesthetic values; transportation and storage of floodwaters; prevention of erosion; and to

implement the policies of the General Plan and the Local Coastal Program Land Use Plan.

#### Sensitive Habitat -

The purposes of this chapter are to minimize the disturbance of biotic communities which are rare or especially valuable because of their special nature or role in an ecosystem, and which could be easily disturbed or degraded by human activity; to protect and preserve these biotic resources for their genetic scientific, and educational values; and to implement policies of the General Plan and the Local Coastal Program Land Use Plan. (code § 16.23)

#### Erosion Control –

Purpose is to eliminate and prevent conditions of accelerated erosion that have led to, or could lead to, degradation of water quality, loss of fish habitat, damage to property, loss of topsoil and vegetation cover, disruption of water supply, and increased danger from flooding, and to implement Local Coastal Program land use policies. (code § 16.22)

#### Grading -

The purpose of this chapter is to safeguard health, safety, and the public welfare; to minimize erosion and the extent of grading; to protect fish and wildlife; to protect the watersheds; to insure the natural appearance of grading projects; and to otherwise protect the natural environment of Santa Cruz County. (code §16.20)

While these codes do speak to the issues of water resource or aquatic habitat protection generally, none of them speak specifically to the specific complexity of karst systems. For instance, the 20ft depth to groundwater mining limit is plainly deficient in consideration of the extreme groundwater dynamics exhibited in karst systems. Furthermore, there is no language in the code that addresses the seasonal or hydrologic year variation in groundwater elevations, potential for pollution or differential weathering induced by anthropogenic activity. As a result, permit process and subsequent permit restrictions are thereby very open to interpretation by individual County staff who may not be afforded the luxury of complete knowledge of the hydrologic complexity of a given project site.

While many of the issues of concern can be addressed in the context of multi-agency/disciplinary permit-related CEQA review, a more comprehensive and equitable approach for protecting karst would be development of KPZs and related karst-specific codes.. State and federal regulations oriented at protecting water resources are similarly deficient. For instance - the Federal Clean Water Act and State Porter-Cologne Water Quality Control Act - speak to protection of “beneficial uses” of water, but are generally more focused on stormwater and point discharges of pollutants. Discharges of sediment to groundwater are an unusual occurrence – perhaps only occurring in karst systems, and state and federal clean water regulations generally do not address them, nor do they have a regulatory mechanism for proactively preventing potential discharges to karst systems due to development activities. Furthermore, staff of respective agencies empowered with regulatory authority over such issues – should they even have the opportunity

or resources to engage in such matters - are (again) generally not well versed in the complexity of karst systems or the unique threats to beneficial uses that may be posed by development activities around them.

*Conclusions:*

Even during drought periods, karst systems of Santa Cruz County provide a substantial portion of the drinking water for well over 90,000 County residents. and persistent cool water for anadromous fisheries and other aquatic habitat. Local karst is unique due to seismic, tectonic, erosion, hydrologic, climatic and other factors which are generally more severe here than many other places where karst occurs. Nevertheless, California's regulatory environment is substantially different than elsewhere where karst occurs. When local, state and federal regulations are compared to karst conservation policies existing in other regions, the degree of protection provided is clearly incomplete and inadequate to protect these environmental and public health and safety values.

Pressures on Santa Cruz County karst will only increase in the future, and without development and implementation of karst-specific policies similar to the examples seen in other regions, these valuable resources and the numerous beneficial uses it provides will continue to degrade. Clearly, in a time when we are faced with incredible water supply and aquatic habitat conservation challenges, this is not a future that we can accept.

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*Proposed Motion:*

*Understanding that economic and staff resources as well as limited data availability will not support initiation of the development of a comprehensive County-wide karst protection policy at this time, the WAC recommends that Environmental Health staff coordinate with Planning Staff to chart a course of action for the development of a pilot karst protection policy in the Bonny Doon area - including the recharge area of Liddell Spring - and return to the WAC with an outline of necessary further actions, deliverables and tentative timeline for completion of such a policy at the April 2011 WAC meeting.*

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