



## Discussion Document and Project Experience For Wine Caves

Condor Earth Technologies, Inc.  
[www.CondorEarth.com](http://www.CondorEarth.com)

---

### COMPANY OVERVIEW

Condor has served California, Oregon, Washington and Texas wineries for over 25 years from our California offices in Stockton, Sonoma, Merced and Rancho Cordova. Condor's team of professionals provide engineering and environmental consulting services for a wide range of projects and clients. Our wine cave and tunnel design services have been used on over 250 projects over the past 25 years. Condor is a 100% employee owned firm with approximately

50 employee-owners. Our staff includes over 25 professionals consisting of civil and geotechnical engineers, engineering geologists, environmental geologists and hydrogeologists. Condor's wine cave project support role often begins as early as planning and project scoping, carries through design, permitting and contractor selection, and continues through construction with quality assurance, owner's representative and construction management services.



### CONDOR'S MISSION STATEMENT

*"To provide high quality, professional services for value-enhanced resource management and infrastructure development."*

## **WINE CAVES YESTERDAY AND TODAY**

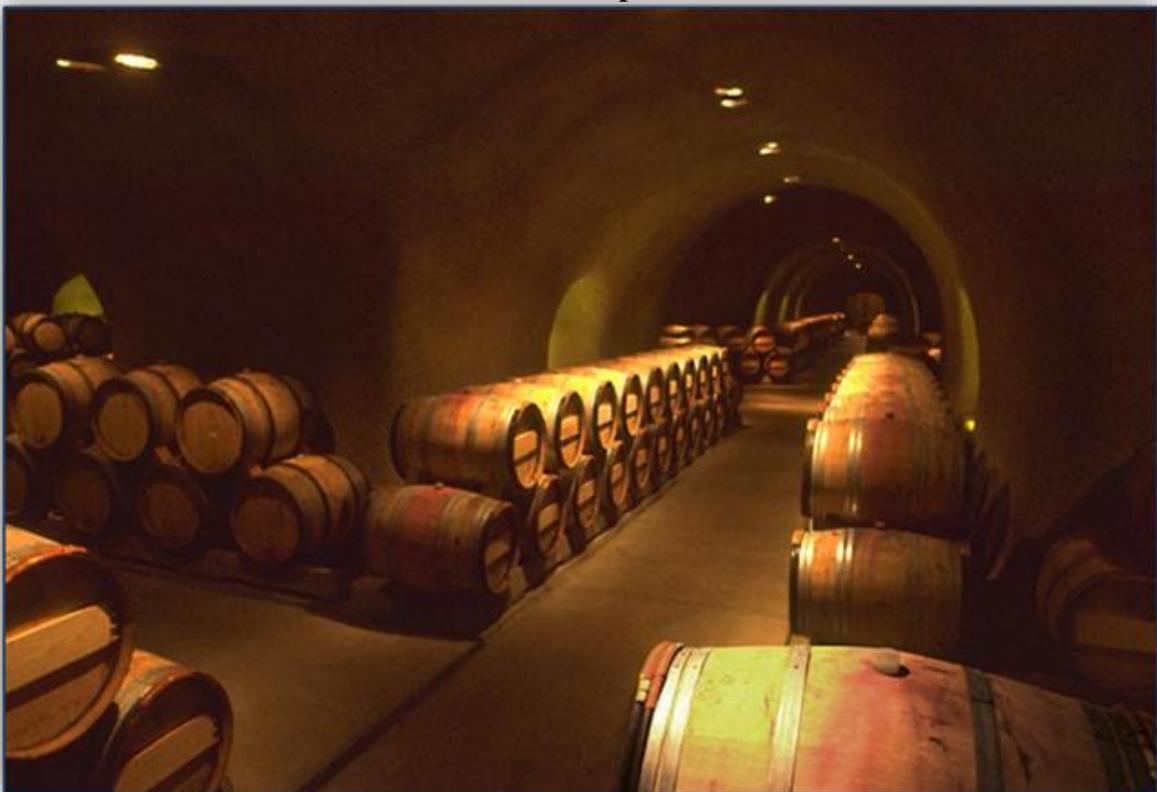
The history of wine cave construction in the United States dates back to the late 1850's or early 1860's in the Napa/Sonoma Valley region. California's first wine cave was constructed at Buena Vista Winery in Sonoma. Soon after, Jacob Schram founded Schramsberg Vineyards near Calistoga, California in 1862. Eight years later, Schram found a new job for the Chinese laborers who had recently finished digging and blasting tunnels and grades over the Sierra Nevada Mountains for the Union Pacific Transcontinental Railroad. He hired them to dig a network of caves through the soft Sonoma Volcanics Formation rock underlying his vineyard.

Over the last several decades, the wine industry has experienced a growing interest in the development of wine caves and other underground structures. Condor assists with project feasibility, engineering, design, permitting and construction

support. This has often involved a multi-staged effort to:

1. Identify suitable sites for development of facilities.
2. Evaluate local, state and federal permit requirements to obtain project entitlements.
3. Undertake geologic survey work to identify ground conditions suitable to cave development.
4. Provide geotechnical investigations and exploration for facilities construction.
5. Provide scope and plans for site development, including cave, shaft, and portal wall engineering and design.
6. Develop construction bid documents for solicitation of construction contractor bids.
7. Provide qualified on-site construction management, professional observation, and materials testing and special inspections.

Condor has provided support services  
to assist clients with the development of their wine caves.



## **WHY BUILD A WINE CAVE?**

Most people are amazed to learn that Condor has been involved in the feasibility, design and construction of more than 250 wine caves, including the largest barrel storage cave in North America and possibly the world. So, why do people build caves? The answer lies in the economic and marketing advantages of producing and storing wine underground.

### **HUMIDITY**

High humidity serves to minimize evaporation. Winemakers consider that humidity of over 75% for reds and over 85% for whites are ideal for wine aging and barrel storage. Humidity in wine caves ranges naturally from 70 to 90%.

### **EVAPORATION**

In Northern California and similar locations, wine barrel evaporation in a surface warehouse without humidification is on the order of 4 gallons (15 liters) per each 60 gallon (227 liter) barrel per year. In a wine cave, barrel evaporation is reduced to about 1 gallon (3.8 liters) or less per barrel per year. Because red wines are usually barreled and aged for 2 years, this represents a 10% gross volume loss difference. For white wines, which are barreled and aged for about 1 year, a 5% loss difference is realized.

### **TEMPERATURE**

The wine industry has long considered that a constant temperature between 55°F and 60°F (13.0°C and 15.5°C) is optimum for the storage and aging of wine. The mean annual temperatures in Northern California result in a uniform underground temperature of about 58°F to 62°F (14.5°C); near optimum for wine caves. With a surface warehouse comes the energy consuming requirement to cool, heat, and humidify. While the most basic wine cave can cost in excess of \$175 per sq. ft. to construct, lower energy costs result in a net savings over the mid-and long-term.

### **LAND PRESERVATION**

In the Napa-Sonoma wine growing region, as in many areas of California and elsewhere, land values are at a premium. Non-agricultural development is often restricted. A storage warehouse and even winery buildings reduce the land available to grow grapes, impacts open space and natural habitats, and preclude other

land uses. Land-use regulation in California places strict limitations on the types and locations of land development. Many land use restrictions and permitting requirements do not apply to underground space. In California there are an estimated 250 to 300 caves currently in use for wine production, wine aging, barrel storage, tasting rooms, art galleries, private collections and events, and even water storage (to replace surface water tanks).

### **MARKETING**

Marketing is an important component of the modern wine industry, and many caves serve varied marketing and public relations functions. Recently constructed caves contain commercial and private kitchens, wine libraries, concert and exhibit halls, staff offices, elevators, restrooms, and other amenities. Some have high-end interiors, including ceramic and stone flooring, masonry-lined walls and ceilings, sculpture and artwork, mood lighting, fountains, waterfalls, and chandeliers. At Stag's Leap Wine Cellars, a Foucault pendulum swings continuously across a bed of black sand in the central exhibit hall.



### **CONSTRUCTION**

The challenge for the design and construction of most wine caves is to create a fairly wide span in weak rock with low cover. The size of a typical wine barrel storage cave is 13 to 20 feet (4 to 6.1 m) wide and 10 to 13 feet (3 to 4 m) high. Underground wineries often utilize tank rooms that are 17 to 22 feet high and 24 to 32 feet wide. Some constructed cave chambers, however, range up to 85 feet (30 m) in width and 50 feet (15 m) in height; difficult to achieve in poor quality rock.

## **CAVE LAYOUT AND STRUCTURAL SUPPORT**

The construction of cave interiors can be complicated by the elaborate curves and labyrinth-style floor plans selected by some owners for their wine caves. As the ground surface slopes upward, providing more cover and usually sounder rock, caves can accommodate multiple drifts. Where possible, the cave is designed and constructed to provide at least 1.2 times their width of cover at intersections. Room and pillar layouts, reminiscent to underground mine design, provide an economical construction arrangement. Tunnel legs are usually 30 to 100 feet (9 to 30 m) in length and pillars are typically a minimum of 20 feet (6 m) wide.

Reinforced shotcrete ground support is utilized at the tunnel portals and in the interior of the wine caves. At the portals, soil nail and shotcrete walls are typically used for permanent support and are constructed from the top down in lifts. Soil nails are installed on 4 to 6 feet (1.2 to 1.8 m) centers in both the horizontal and vertical directions. The shotcrete is typically a minimum of 8 inches (20.3 cm) thick and reinforced with welded wire fabric. The typical 4,000 psi (28 MPa) design strength mix is applied using the wet mix process.

## **UTILITIES AND INTERIOR FINISHES**

Interior finishing of the caves is an integral part of the construction process. Water seepage mitigation details are an important consideration for the interiors of wine caves. Wet spots and water seeps are unsightly, and can cause maintenance and safety problems. Moisture vapor migration through the cave liner, however, is desirable to maintain humidity.

In order to support their varied uses, wine cave complexes contain many different utility systems. These include systems for hot and cold domestic water, process wastewater, electric power systems for processing equipment, lighting, sound and water features, emergency

power, compressed air and inert gas systems, communications and radio relays, automatic ventilation, and computerized sensors and climate controls.

## **SPECIFIC SUPPORT CONDOR CAN PROVIDE**

The following is a brief outline of services that Condor provides:

1. **Site Feasibility Review** – Condor provides consultation services to assess the feasibility of a proposed site for use as a wine cave facility.
2. **Site Subsurface Investigation** – Condor performs geologic investigations to develop design and engineering parameters for development and construction of wine cave facilities.
3. **Cave Construction Drawings** – Condor provides tunnel and geotechnical engineering, design, specification, and related services for tunnel excavation and support.
4. **Construction Management** – Condor has provided many clients with construction management support on underground construction projects throughout California, Oregon, Washington and Texas.
5. **Materials Testing** – Condor maintains qualified staff and laboratory facilities to support materials testing and special inspection requirements for construction activities.
6. **Phase I Site Assessment (PSA)** – Potential environmental liability can be assumed inadvertently when acquiring property or establishing facilities on property that has been the previous location of industrial activities. A Phase I site assessment will help establish and/or confirm a “baseline” of environmental condition of the site prior to the establishment of new facilities.

## CONDOR CAPABILITIES

In addition to specialized wine cave services, Condor provides other services to the wine and agriculture production industries.

### CONDOR'S CAPABILITIES INCLUDE:

#### Chemical Risk Management/Industrial Compliance

- RMP, CalARP, and PSM Programs and Compliance Support
- Environmental Compliance Auditing
- SPCC Plans
- Industrial Storm Water Compliance

#### Water Reuse/Groundwater Supply

- Groundwater Availability and Quality Assessment
- Aquifer Recharge and Recovery
- Groundwater Monitoring Programs

#### WDR/NPDES Services

- Report of Waste Discharge (ROWD) FOR Waste Discharge Requirements (WDR)
- Groundwater Work Plans
- Onsite Wastewater Treatment Systems (OWTS)

#### Tunnel and Shaft Services

- Tunnel Design Engineering
- Construction Plans
- Portal Design

- Construction Management and Owner's Representative

#### Geotechnical Services

- Geotechnical Investigations
- Tunnel and Rehabilitation Design
- Retaining Wall Design
- Soil Nail and Tie-Back Design
- Geosynthetic Liner Design
- Slope Stabilization Design and Construction Engineering
- Geo-hazard Studies

#### Storm Water Management

- Industrial, Municipal, and Construction NPDES Services
- Qualified SWPPP Developer/Practitioner Services (QSD & QSP)
- BMP Development
- Erosion Control Plans
- Storm Water and Surface Water Sampling Programs
- Monitoring and Reporting Programs (MRPs)

## VALUE DRIVEN APPROACH TO ADDRESS THE PROBLEM

Condor's focus is to provide qualified, experienced professionals who strive for creative and innovative solutions to achieve project goals at reasonable costs. We implement our focus as a continuous improvement process that consists of six components.

- **Define** with the client their requirements and their expectations, as well as define project boundaries and a roadmap to accomplish project goals articulated in a specific Scope of Work.
- **Execute** the Scope of Work, meeting project timelines by establishing achievable critical path items.

- **Communicate** relevant aspects of Condor's work as necessary using conventional and electronic reporting medium to keep our clients informed and to eliminate surprises.
- **Measure** the performance of the project team by collecting and reporting on project parameters and metrics including project budget, schedule, achieving client needs, and client involvement in alternatives.
- **Analyze** what we can do to improve our customer's experience.
- **Seek** feedback on our performance and meeting of our clients expectations.



## **PROJECT ORGANIZATION**

Condor provides our clients with a single contact with direct responsibility for all Condor services. Within this framework, Condor's technical experts provide input and support as our client manager works with our client to identify needs and develop solutions. As individual projects are identified within the selected solution, project managers manage each phase of the project that is within their area of expertise. Our client manager ensures the seamless integration of Condor's services throughout various project activities.

## **STAFF QUALIFICATIONS**

Scott W. Lewis, PG, CEG.

*Principal Engineering Geologist and Senior Tunneling Consultant*

Mr. Lewis has over 30 years of experience in geologic investigations and construction/repair of tunnels, structural foundations, landslides, slope stability, dam sites, and geologic hazards. He has served as the project manager and/or principal investigator on hundreds of tunnel and wine cave feasibility and construction projects. His specialty is in coordinating and performing field investigations, project feasibility, tunnel

evaluation, construction plans and specifications preparation, and construction management and supervision.

Andrew S. Kositsky, PE, GE

*Senior Civil/Geotechnical Engineer*

Mr. Kositsky serves as Condor's lead Design and Geotechnical Engineer for tunnel, wine cave, dam, retaining wall and shoring projects. He is responsible for preparing Design Submittals and Geotechnical Engineering Studies. He has over 25 years of experience in geotechnical investigations, foundations, slope stabilizations, tunnel and shotcrete wall designs, and related work. Mr. Kositsky provides engineering and peer review services for wine cave projects throughout California and elsewhere.

Brad Peterson

*Project Director*

Mr. Peterson is a geologist with more than 30 years of experience in the construction industry with emphasis in project management, construction management, geotechnical engineering, materials testing and special inspection for various types of public and private infrastructure. Mr. Peterson is experienced in supervising and managing teams of engineers and inspectors on large scale construction projects in a wide variety of markets including commercial, residential, educational and healthcare facilities, transportation infrastructure and water resources. Mr. Peterson is an excellent communicator, is well organized, and is effective in the implementation of quality assurance/quality control procedures that enhance overall project quality and performance. Mr. Peterson is uniquely qualified to serve as Project Director based on his technical expertise in the industry and his broad field experience.

Ronald L. Skaggs, PE, GE

*Principal Engineer and Vice President*

Mr. Skaggs has over 25 years of experience in geotechnical engineering, construction quality assurance, and project management. He provides senior peer review for tunnels and wine caves and construction projects. His experience includes geotechnical investigation, design plan and specification preparation, and construction oversight.

Kyle V. White, PG  
*Associate Geologist*

Mr. White serves as associate tunnel geologist for Condor and is responsible for tunnel logging and mapping, construction management, and inspection for general conformance with project specifications.

Emily Kentta  
*Staff Tunnel Geologist*

Ms. Kentta serves as a tunnel geologist for Condor and is responsible for tunnel logging and mapping, construction management, and inspection for general conformance with project specifications.

Sierra Brandt  
*Staff Engineer*

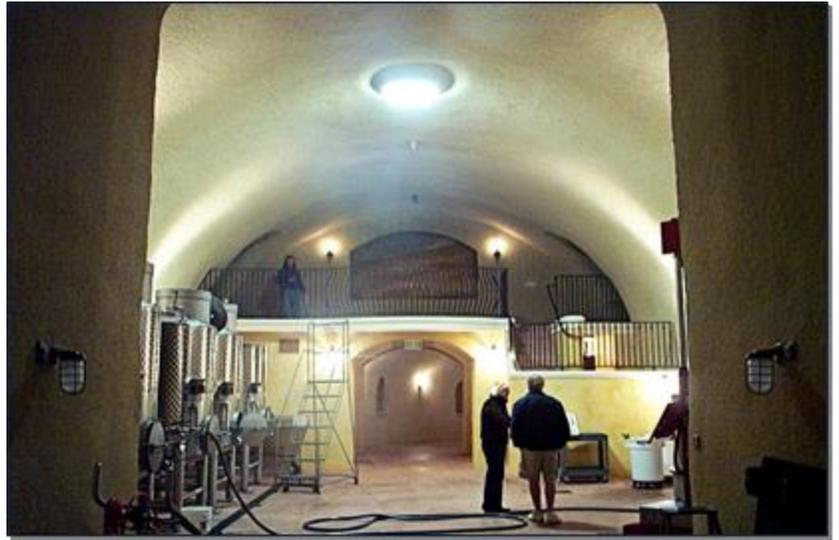
Ms. Brandt serves as a staff Engineer for Condor and assists in design services of tunnels, dams, wine caves, portals and shotcrete retaining walls.

Michael Gowring  
*Underground and Heavy Construction Consultant*

Mr. Gowring is an associate consultant with over 40 years of underground and heavy construction experience. He has served as tunnel project manager for various construction companies. Mr. Gowring provides project constructability and cost estimate services for tunnel and wine cave projects.

Gregg E. Korbin, PhD  
*Geotechnical Consultant*

Dr. Korbin is an Associate Geotechnical Consultant that has worked with Condor on several projects over the past 25 years and with Mr. Lewis over the past 30 years. He has extensive experience in the design and construction of underground works. If needed, Dr. Korbin will provide technical analyses, design, and peer review services.



Dr. Kerry Cato, PhD, CEG,  
*Senior Engineering Geologist*

Dr. Cato is a Senior Engineering Geologist with extensive experience in site geology, engineering geology, and geotechnical studies in Southern California. Dr. Cato provides senior level consulting support for Condor wine cave and tunneling projects, including site geologic studies, subsurface exploration, and geologic hazards studies. Dr. Cato has specialized experience in geologic siting and grouting expertise of dams and tunnels, and has served on expert panels for major civil works projects.



The following table includes a list of representative clients and work performed by Condor:

<b>Client/Owner</b>	<b>Project</b>	<b>Services</b>
<b>The Napa Valley Reserve</b>	Wine Cave and Portals	Project feasibility, cave construction plans and consultation, portal design, cave bid documents, construction monitoring and management
<b>Vineyard 29</b>	Winery, Caves and Portals	Project feasibility, cave and portal design, landslide hazard evaluation, geotechnical exploration and report, QA and construction monitoring, special inspection and materials testing
<b>Brassfield Estate Winery</b>	Wine Cave, Portals and Elevator Shaft	Project feasibility, site exploration, design, construction drawings, construction observation, materials testing and special inspection
<b>Ferrari-Carano Winery</b>	Winery and Caves, Reservoir, Access Road, and Portals	Project feasibility, geotechnical exploration and report, cave design, access road design, QA and consultation during construction, materials testing
<b>Staglin Family Vineyards</b>	Underground Winery, Caves, and Portals	Pre-construction site evaluation, site exploration, design, geotechnical report for cut/cover, QA and design consultation during construction
<b>Bryant Family Vineyard</b>	Winery, Caves, and Portals	Project feasibility, geotechnical exploration and report, cave and portal design, landslide hazard evaluation, QA and construction monitoring, materials testing
<b>Stag's Leap Wine Cellars</b>	Wine Caves, Portals, Slopes, Reservoir, Visitor Center	Pre-construction evaluation of tunnel conditions, geotechnical exploration and reports, design, QA and consultation during construction, materials testing, geotechnical report
<b>Gloria Ferrer</b>	Wine Caves, Portals, and Winery Expansion	Portal, tunnel and cut/cover design, grading and utility plans, QA and consultation during construction, materials testing
<b>Kathryn Hall Winery</b>	Winery, Caves, and Portals	Project feasibility, cave design, geotechnical exploration and report, portal and retaining wall design, QA and consultation during construction

Client/Owner	Project	Services
Jarvis Vineyards	Underground Winery, Wine Caves, and Portals	Exploration, design, QA, construction monitoring, materials testing, and construction management
Rutherford Hill Winery	Wine Cave	Tunnel liner remediation design, construction monitoring and testing
Gallo of Sonoma	Winery and Cave	Project feasibility, evaluation report
Schramsberg	Wine Cave	Stability evaluation and repair design of existing cave
Arkenstone Vineyard	Underground Winery	Tunnel, shaft and portal design, construction monitoring and consultation, materials testing and special inspection
Calera Wine Company	Wine Cave, Portal, Cut/Cover	Project feasibility, site exploration, geotechnical report, design, construction management, construction observations
Buena Vista Winery	Wine Cave, Water Storage Tunnel	Rehabilitation of ca. 1850's wine cave, ground support and tunnel design and construction management
Continuum Estate	Water Storage Tunnel	Tunnel design and construction observations
Oak Mountain Winery	Wine Cave	First cave project in Temecula, CA. Project feasibility, site exploration, geotechnical report, design, construction management, construction observations
B Cellars Winery	Wine Cave and Elevator Shaft	Project feasibility, site exploration, geotechnical report, design, construction management, construction observations
Covert Estate	Underground Winery	Project feasibility, site exploration, geotechnical report, design, construction management, construction observations
Sinegal Estate Winery	Wine Cave and Shotcrete Retaining Walls	Project feasibility, site exploration, geotechnical report, design, construction management, construction observations, and landslide hazard evaluation
Cairdean Vineyards	Wine Cave and Portals	Site investigation, geotechnical report, cave and shotcrete wall design, construction observations

<b>Client/Owner</b>	<b>Project</b>	<b>Services</b>
<b>Realm Cellars</b>	Wine Cave and Ag Building	Initial feasibility, conceptual design, geotechnical report, cave and portal design
<b>Papa's Perch</b>	Private Use Cave and Cellar	Initial feasibility, geotechnical report, cave and portal design, engineering and construction observations, materials testing
<b>The Culinary Institute of America – Greystone</b>	Storage Caves and Retaining Walls	Geotechnical investigation, design, consultation
<b>Sisterdale Vineyards, TX</b>	Wine Cave	Initial consultation, conceptual design
<b>Girard Winery, Rudd Wines</b>	Winery, Caves, Portals, and Shaft	Project feasibility, geotechnical exploration and reports, tunnel/shaft support design, QA and consultation during construction, materials testing
<b>Leslie Rudd Investment Company, Rudd Winery</b>	Elevator Shaft and Related Improvements	Project feasibility, design, construction observations, special inspections
<b>Halter Ranch</b>	Winery, Cave, and Portals	Feasibility, tunnel design and report, development consultation, shotcrete wall design, construction observations
<b>Hamel Family Winery</b>	Wine Cave and Portals	Site investigation, geotechnical report, cave and shotcrete wall design, construction observations
<b>Dragonfly Investment Group</b>	Black Mountain – Spring Tunnel	Evaluate existing conditions of tunnel, recommendations and design
<b>O'Shaughnessy Vineyard</b>	Winery, Caves, and Portals	Project feasibility, geotechnical exploration and report, tunnel/portal support design, QA and consultation during construction



Over the past 34 years, Condor has steadily grown in capability and experience, and we understand the many challenges that wineries and project proponents are facing today. Condor offers many services and capabilities that can assist in successfully meeting these challenges and successfully completing your projects. Thank you for this opportunity to provide you with a discussion of our experience and how this can benefit your project. We look forward to the possibility of providing you with support in the near future.

