RECOMMENDED ACTION AND JUSTIFICATION:

Recommend variance from statutory setback distance of 100 feet between well and septic leachfield for APN 006-160-030, Lloyd Johnson, based upon uniqueness of property regarding geology and hydrology.

The setback distance from well and septic referred to above is found in County Code Section 13.08.090, Rules and Regulations Section .070. The rationale behind the codified setback is to maintain protection of drinking water from contamination resulting from the sewage leachfield. The 100 foot setback is a safe distance and in many cases could safely be reduced but that would depend on geological circumstances. Mr. Johnson has submitted a geologic report (Attachment A) addressing the issue of the local geology, concluding that a setback of 60 feet or more on this particular parcel is adequate for protection of public health issues. See attached memo for more details.

BACKGROUND AND HISTORY OF BOARD ACTIONS

Similar variance requests have been made by six (6) owners of parcels located in the same geologic area. All six requests were entertained and relevant geological data were reviewed by the Health Department at that time. All six requests were recommended to the Board of Supervisors with certain protective conditions and time has proven the safety of this process. (See Resolutions 93-603, 96-0604, 01-82, 01-235, 01-236 and 03-94).

ALTERNATIVES AND CONSEQUENCES OF NEGATIVE ACTION:

Do not approve variance, owner will be required to develop property utilizing other alternatives.

<table>
<thead>
<tr>
<th>Financial Impact?</th>
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<th>No</th>
<th>Current FY Cost:</th>
<th>Annual Recurring Cost:</th>
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<tr>
<td>( ) General</td>
<td>( ) Other</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Attachments: Letter to Board of Supervisors
ORD Report/Plans dated 6/15/11
Section 8 and 9 Well Water Standards

The foregoing instrument is a correct copy of the original on file in this office.

Date: ____________________________
Attest: MARGIE WILLIAMS, Clerk of the Board
County of Mariposa, State of California

By: ____________________________
Deputy

Revised August 2011
September 23, 2011

TO: Board of Supervisors

FROM: Charles B. Mosher, M.D., MPH, Health Officer

SUBJECT: Variance request on Johnson property, APN 006-160-030

BACKGROUND:

This property is located in Foresta on a small lot measuring 50 by 100 feet. The owner’s desire to rebuild on this property after the Foresta Fire presents the now familiar challenge of maintaining setbacks required by County Code applicable to both planning issues and public health issues. In March 2011, Mr. Johnson received a permit for a sewage disposal system on this lot.

On 8/01/11, Mr. Johnson submitted a geological report prepared by Geotechnical Research and Development which supports, on the basis of the underground geology on the lot, the reduction of the setback distance between well and septic below the 100 feet in Mariposa County Code, with the proviso that it be no closer than 50 feet (See Attachment A).

Other issues with this property have intervened between August and the date of this memo.

Review by staff of the geologic report shows it to be consistent with geologic reports submitted on the previous six (similar) requests for variance from 100-foot setback submitted by owners of other lots in Foresta. Applying the same standards as those applied to previous cases, with the exception of not requiring the owner to fund an outside hydro-geologist to review the geologic report (which was accomplished on the
first such case, but which the Health Department has been able to do in house since then) leads to the conclusion that the Health Department can recommend the requested variance to the Board of Supervisors without undue concern about negative public health impacts to the drinking water. The specifics are as follows:

I. Applicable codes:

A. County Code Section 13.08.090 Rules and Regulations Section .070 “minimum setbacks”


D. Regional Water Quality Control Board guidelines for on-site sewage disposal.

II. Analysis of request:

Health Department staff analysis of the geologist’s report indicates the following findings:

A. Reasonable evidence that water inflow into the site of the proposed well will come from the opposite direction of the site of the current leach field.

B. Previous experience in the area with wells indicating a first recharge of water at a depth between 70 and 90 feet below the surface.

C. An adequately constructed annular seal consistent with current Department of Water Resources standards of at least 50 feet is proposed.

D. The sewage disposal system is a proven technology with a track record of adequate microbacteriological cleansing such that, in the geologic setting found at the subject APN, the commingling of treated leachate from the proposed leaching area and ground water recharge serving the well is extremely remote.

E. The geological report indicates that there is a solid granite shelf located between the proposed well and the approved sewage disposal area, which slopes away from the proposed well.
RECOMMENDATION:

Staff finds that the geological conditions on this lot are unique and sufficient to reasonably allow a closer encroachment between leach field and well than the 100-foot minimum established by County Code. We recommend granting the variance with the following conditions (consistent with conditions placed on previous variances):

1. Setback distance to encroach no closer than sixty (60) feet.

2. An annular seal of at least fifty (50) feet in depth, if the geologist is on-site during drilling and determines that the seal will be at least 20 feet into solid un-weathered and unfractured granite or 100 feet in depth if the geologist is not present during drilling, to be placed with the well.

3. Quarterly bacteriological testing to be performed by the property owner on water from the private well on said APN to include coliform count and heterotrophic plate count. Copy of results to be sent to the Health Department. (This condition may be waived after two years of monitoring).

4. In the case of any bacteriological tests of water demonstrating presence of coliform organisms or significant increase in the heterotrophic plate count, the County Health Department will be immediately notified and the drinking of raw water from that well will be immediately suspended.

5. In the event that the water from said well should demonstrate bacteriological contamination and that standard and reasonable attempts to decontaminate the well fail, after three such attempts the landowner will destroy the well.
June 15, 2011
GRD 09031
MARIPOSA COUNTY
HEALTH DEPARTMENT

Mariposa County Health Department
5100 Bullion Street
P.O. Box 5
Mariposa, CA 95338

Attn: Mr. David L. Conway

Re: Revised Report
Mariposa County Assessor’s Parcel 006-160-0300
Lot 4 of Block 7, Foresta Subdivision, Yosemite National Park

INTRODUCTION

The purpose of this letter report is to present a revision to GRD’s report dated April 18th 2011. The original field work upon which the report was based was conducted in 2009. Since that time, substantial grading efforts related to the installation of the septic system have occurred. The grading resulted not only in modification of the topography but also removal of vegetation and downed logs. The septic tank and sand filter bed now cover approximately southern third of the site.

On June 2nd 2011 GRD received an e-mail from the Mariposa County Health Department raising questions concerning the subsurface topography of the contact between the decomposed granitics and the unweathered granitic bedrock based on a line shown on Figure Three. The question was based on a contact line shown between the DG weathered “soil” material and the relatively unweathered granitic bedrock. It was proposed that another seismic traverse might possibly be appropriate to be conducted at right angles to Seismic Traverse Two and that a cross section along the alignment of Traverse Two would be appropriate.

Given the time that has elapsed since our original work on the project site, the undersigned conducted another field visit to the site on June 9th, 2011. As stated in the above first paragraph, substantial changes to the project site topography have occurred. Prior to the field visit, a cross section along Seismic Traverse Two was drawn as shown on the additional Figure 4 to this document. In addition, the original Figures One and Two have been revised to present a clarified indication of the site layout and cross section along Seismic Traverse One. The topography has not been revised to reflect current conditions as the original topography is what bottomless sand filter and septic tanks were constructed in. The location
of the proposed well was changed to the northwestern corner of the property in place of the northeastern corner indicated in the April 2011 report.

This revised report is being presented to present updated and clarified background data for consideration by the County in evaluating the request of Lloyd Johnson concerning his request for variances to County Code that will allow for the permitting and construction of a single family, two bedroom residence on the referenced property in Foresta. The proposed construction will require both a domestic water well and an on-site wastewater treatment and disposal system on a parcel of only 5,000 square feet. The scope of this report includes the presentation of data that has been gathered with respect to the water and wastewater disposal on the subject site.

PROJECT SITE LITHOLOGY

The site is underlain by granitic rocks similar to those exposed in the local area. The surface exposures of granitic rock in the area represent either surface exposures of insitu bedrock or are typically remnant boulders of erosion surrounded by decomposed granitic soil. Past trenching efforts by the Mariposa County Health Department have revealed that up to eight feet of “brown silty sand” underlies the area of the property proposed for sewage disposal purposes. One of the two trenches excavated for profiling revealed mottling at 54 inches and free water at 78 inches below the existing ground surface. Accordingly, it was stated that “this soil is not conducive to having a standard septic system” and required that a “special design sewage disposal system” design be designed. (David Conway, June 24, 2009 letter to Lloyd Johnson).

The “brown silty sand” referenced above may also be referred to, in common vernacular as “decomposed granite” or “DG”. Past experience in the local area has revealed that the granitic rocks from which the DG has been formed are subject to joints or “fractures” in the otherwise solid rock masses. The major joint sets are measured in terms of feet whereas the minor joint planes are on the order of a foot. The spacing between two rock surfaces marking minor joint planes can vary from several inches, due in part to erosion, to a rapidly decreasing fraction of an inch within a short vertical distance.

The DG is formed from the erosion products of the granitic rocks. It is common for randomly spaced, both within vertical and horizontal space, for residual boulders of erosion to be contained within a matrix of DG. The DG will traditionally increase in density with depth. Accompanying the increase in density with depth will be a decrease in permeability. Oftentimes, careful observation of trench sidewalls will reveal a mottling of soil color formed by the oxidation of iron containing mineral grains in the DG as a result of seasonal groundwater (soil water) being present.
SEISMIC TRAVERSSES

To gain additional information concerning the sub-surface conditions, especially to assist in characterization of the soil-decomposed bedrock interface, two seismic traverses were extended at the locations shown on Figure Two. The seismic method of subsurface exploration is based on inducing a shock wave into the ground at a given distance from a geophone receiver. The shock wave travels through the subsurface for the given distance in a recorded time. Given the distance and time of travel, the velocity of the subsurface materials can be calculated. The velocity is a function of the density of the subsurface materials, i.e. the denser the subsurface materials encountered the shorter the time required for the shock wave to travel the given distance and, consequently, the higher the velocity representing the earth materials will be.

Based on changes in the shock wave travel times and the general shape of the curve resulting from an accumulation of a number of monitoring points, it is possible to deduce the subsurface structure along a line of traverse. A review of the data gathered indicates that the soil layers overlying the granitic rock are greater than thirty feet below the ground surface and in all probability somewhat variable in thickness. In addition random points were noted in the data reduction for both traverses that indicate that the decomposed granitics are not uniform in density and probably contain residual boulders of granitic rock that were more resistant to the decomposition agents that resulted in the surrounding DG matrix.

ONSITE WASTEWATER TREATMENT AND DISPOSAL SYSTEM

An onsite wastewater treatment and disposal system has been installed on the property with the major components reported to be in the locations indicated on Figure One. The system was designed by O.S.T. System Designs under the signature of Armando Flores, Registered Environmental Health Specialist # 6579. The system design was approved by the Mariposa County Health Department on July 28, 2009.

The system design consists of a 1500, two chambered Nottingham septic tank accepting effluent from the proposed dwelling into the first chamber of the tank for gravity settling of solids and primary treatment. The effluent then flows into a second chamber which is utilized both for additional polishing of the effluent and as a pump chamber. Float switches installed in a screened enclosure control the effluent pump which pressurizes the effluent from the pump chamber to the intermittent sand filter in controlled doses. The effluent is sprayed in a uniform manner through a lateral system that is placed over a sand bed. The sand in the sand bed is of a specific gradation employed to do a final polishing and treatment of the effluent which trickles through the sand into the native, decomposed granite subsoil.

The bottomless, intermittent sand filter serving the future wastewater treatment and disposal needs of the proposed residence is located in the southwestern quadrant of the property with the proposed location for the well being in the northwestern corner of the property. The treated effluent will be discharged from the bottom of the sand filter into loamy sand. In their paper entitled “Estimating Wastewater Loading Rates Using Soil Morphological Descriptions” found in the Proceedings of the Sixth Symposium on Individual and Small Community Sewage Systems, Tyler et al determined that the safe loading rate for loamy sands is 0.6 gallons per day per square foot, a loading factor implying a factor of safety for
the designed disposal system being in excess of two. The topography in the area of the sand filter bed slopes gently toward the southeastern property corner. The anticipated flow path for the treated effluent through the system will be toward the south-south east.

The native soils serve as the medium to both for final treatment resulting in a polished effluent and to disperse the treated liquid into the natural subsurface environment. The technology employed by the bottomless sand filter system designed by Mr. Flores is a well proven technology that has been successfully employed under similar environmental conditions for several decades.

DOMESTIC WATER SYSTEM

In addition to the wastewater treatment and disposal system, the proposed construction of the Johnson Cabin will require that an onsite well for the domestic water requirements to be permitted and drilled on a parcel of only 5,000 square feet.

Mariposa County Code 17.108.130 A relates to the minimum public street frontage setback when it states that:

“The front yard setback shall be a minimum of less than twenty-five (25) feet from the nearest point on the front property line or edge of any public street, easement of right of way offered for dedication, and a minimum of fifty-five (55) feet from the center line of said street, easement, or right of way.”

The northern property line of the Johnson parcel is defined to the north by Le Conte Way, an undeveloped roadway easement fifty feet in width. The Johnsons propose to drill a new well as close as possible to the northeastern property corner. This is a permitted use within the setback area (Mariposa County Code 17.108.130.D.1). The trace of the Le Conte Way easement is not marked, developed nor commonly utilized for road purposes. At the time of our field work, it was not possible to visually discern the roadway easement from the adjacent properties that it was designed to serve. It is unlikely that the road will be developed in the foreseeable future as all adjacent parcels belong to the National Park Service.

Due to the lack of other wells within a significantly close proximity to the Johnson property, it is not possible to definitively describe the groundwater environment below the site. However, past work by GRD in the Foresta area has indicated that a typical well in Foresta has a low yield, on the order of 0.5 to 4 gallons per minute. Wells typically will gain their first recharge from a depth of between 70 to 90 feet below the ground surface from fractures in the granitic bedrock which lies beneath approximately 30 to 40 feet of decomposed granitic “soils”.
RELEVANT REGULATIONS

Mariposa County Code 13.16.030 speaks to the County’s well standards. The County Code is based on the California Department of Water Resources Publication entitled Water Well Standards: State of California which is known as Bulletin 74-81. In 1990 the Department of Water Resources published Bulletin 74-90 as a supplement to Bulletin 74-81. In an effort to prevent confusion, the Department combined the two bulletins into an integrated document referred to as Bulletin 74-81 and 74-90 combined which was made public as a web publication. Section 8 and Section 9 of the revised Water Well Standards are presented as Appendix A to this report for reference.

Section 13.16.030.C of the Mariposa County Code speaks to variances being allowed to the requirements of Section 8 and/or Section 9 of the Water Well Standards. The County Code states that “the health officer shall have the power to grant a variance from any provisions of the standards referenced above to prescribe alternative requirements in their place.”

Section 8 of the Water Well Standards relates to well location with respect to pollutants and contaminants and structures. The discussion in subsection A states in part:

“Many variables are involved in determining the “safe” separation distance between a well and a potential source of pollution or contamination. No set separation distance is adequate and reasonable for all conditions. Determination of the safe distance for individual wells requires detailed evaluation of existing and future site conditions. Lesser distances than those listed above may be acceptable where physical conditions preclude compliance with the specified minimum separation distances and where special means of protection are provided. Lesser separation distances must be approved by the enforcing agency on a case-by-case basis.”

The “minimum separation distances” referred to in the above paragraph states in a Table that the minimum horizontal distance between a well and a known or potential pollution source should be 100 feet when the potential pollution source is a watertight septic tank or a subsurface sewage leaching field.

Section 9 of the Water Well Standards relates to the sealing of the upper annular space during well construction. Domestic wells require a twenty foot minimum seal depth below the adjacent ground surface. Section 9 provides detailed specifications for the annular seal’s construction and materials. Implementation and enforcement of the appropriate specifications contained in Section 9 represent the key to successful completion of the Johnson project.
DISCUSSION AND RECOMMENDATIONS

Lithologic cross sections are presented as Figure Three and Four. These cross sections have been drawn along the alignment of Seismic Traverses One and Two. They present a pictorial slice of the earth materials from near the northeastern property corner where it was originally proposed to drill domestic water well toward the southwestern property corner where the septic tank and bottomless intermittent sand filter have been constructed (Figure Three). In addition, Figure Four presents an interpretation of the lithology below Seismic Traverse Two.

The cross sections have been developed based on (1) surface geologic mapping, (2) the results of the Health Department’s trenching efforts, and (3) seismic profiling. The resultant “picture” is one of several feet of silty sand topsoil underlain by decomposed granitics having an average thickness on the order of ten feet. At approximately ten feet, the decomposed granitics become increasingly dense. A review of the raw seismic response times results in the interpretation that the decomposed granitics, contain residual granitic boulders and that the decomposed granitics increase in density with depth below the ground surface. Past work in the project area and review of several local drilling logs indicates that competent granitic bedrock will be found approximately twenty to thirty feet below the existing ground surface.

Figure Five diagrammatically shows the relationship between a well located in the northwestern corner of the property and the bottom of the septic tank. Originally, it was proposed that the well be drilled in the northeastern corner of the property. After careful consideration, it is recommended that the well be placed in the northwestern corner of the property due to its distance from the septic tank which has been installed since the field work for the original report was conducted.

Figure Five shows that providing a sanitary grout seal for the domestic well to a depth of 100 feet beneath the ground surface will result in a straight line distance of over 100 feet between the bottom of the well’s sanitary seal and the bottom of the septic tank which is the nearest component of the septic system to the well.

The undisturbed topography adjacent to the site slopes toward the southeast. As previously mentioned, the construction of the septic system has resulted in the current topography being a modification of that which was observed during the first field session. It appears that the soil removed during preparation of the excavations for the bottomless sand filter and septic tanks was utilized as cover for the bottomless sand filter with the remainder being spread in the proposed house area. The topographic modifications have resulted in changes to the surface runoff patterns that are enhanced by shallow surface drains leading to the drainage swale that runs roughly parallel to the eastern property line, to channel the collected waters in a southerly direction offsite.

The shallow subsurface drainage resulting from percolating waters flows through the near surface soils with the majority flowing down gradient in a manner which parallels the original ground slope which is to say to the east south east. The minority fractions of the percolating waters slowly travel downward through the decomposed granitic soils which increase in their density with depth. The increasing density of the decomposed granitic soils results in a decrease in their ability to transmit water, which in turn causes the waters to seek the path of least resistance toward the east south east, away from the well.
Based on the information gathered and reviewed to date and past experience in both the local area and Foresta in general, the undersigned is of the opinion that the construction of a domestic well at the location proposed in the northwestern corner of the Johnson Property will not present a potential hazard to public health and safety provided that the following items are addressed:

1. The well is constructed in accordance with current standards and regulations under permitting by the County.
2. The well is constructed with a 100 foot seal placed utilizing pressure placement of sealant using Tremie techniques.
3. The recommended depth of sealing may be modified by up to 50 feet beneath the existing ground surface if during drilling the well is observed by the undersigned allowing for a minimum annular seal to be completed a minimum of 20 feet into competent bedrock. The modification would be based on the depth to bedrock and the hardness of the bedrock as an indication of both the degrees of weathering and fracturing.
4. After well completion and development it is recommended that the well water be sampled for compliance with drinking water standards prior to being placed in domestic service. It is further recommended that the well water be sampled once again after completing the completed cabin’s first active season of use.

Based on the outlined review of data and the above items being placed as conditions of approval, it is the opinion of the undersigned that the necessary variances should be granted to the Johnsons which will allow their project to proceed.

This opportunity to be of service is sincerely appreciated. If you have any questions after reviewing this revised report, please do not hesitate in contacting the undersigned.

Respectfully submitted,
Geotechnical Research and Development

Michael R. Flynn, PG 3396, CEG 1127
Expiration date 2/28/13

Attachments:
Seismic Traverse Results
Figures 1 through 5
Appendix One: Water Well Standards Sections 8 & 9

CC: Lloyd Johnson
FIGURE ONE
JOHNSON CABIN SITE LAYOUT PLAN
MARIPOSA COUNTY A.P.N. 006-160-0300
FIGURE TWO
APPROXIMATE SURFACE TOPOGRAPHY
AND LOCATION OF SEISMIC TRAVERSE LINES
1"=10'
VERTICAL AND HORIZONTAL SCALES

BOTTOMLESS SAT FILTER
PROPOSED WELL LOCATION

ORIGINAL GROUND ELEVATION

APPROXIMATE CONTACT BETWEEN THE LOWER LIMIT OF THE SOIL UNIT AND THE UPPER UNIT OF THE DENSE, DECOMPOSED GRANITICS

NOTES:
ORIGINAL GROUND ELEVATION IS KEYED INTO AN ASSUMED DATA POINT WHICH IS TO SAY THAT ALL ELEVATIONS ARE RELATIVE

FIGURE A
CONTOUR MAP OF BOTTOM OF UPPER SOIL UNIT
NOTES:
ORIGINAL GROUND ELEVATION IS KEYED INTO AN ASSUMED DATA POINT WHICH IS TO SAY THAT ALL ELEVATIONS ARE RELATIVE

FIGURE B
CONTOUR MAP OF THE APPROXIMATE CONTACT BETWEEN DENSE TO VERY DENSE DECOMPOSED GRANITIC MATERIAL AND COMPETENT GRANITIC BEDROCK
FIGURE FIVE
GEOLeGIC CROSS SECTION ALONG CROSS SECTION LINE

1"=20'
VERTICAL AND HORIZONTAL SCALES

NW PROPERTY CORNER

PROPOSED WELL LOCATION

CEMENT GROUT ANNULAR SPACE
50'-100' BELOW GRADE TO BE DETERMINED BY PROFESSIONAL GEOLOGIST AT TIME OF DRILLING
APPENDIX A

SECTIONS 8 AND 9
WATER WELL STANDARDS
CHAPTER II. STANDARDS
Part II Construction

Section 8. Well Location With Respect to Pollutants and Contaminants, and Structures.

A. Separation. All water wells shall be located an adequate horizontal distance from known or potential sources of pollution and contamination. Such sources include, but are not limited to:

- sanitary, industrial, and storm sewers;
- septic tanks and leachfields;
- sewage and industrial waste ponds;
- barnyard and stable areas;
- feedlots;
- solid waste disposal sites;
- above and below ground tanks and pipelines for storage and conveyance of petroleum products or other chemicals; and,
- storage and preparation areas for pesticides, fertilizers, and other chemicals.

Consideration should also be given to adequate separation from sites or areas with known or suspected soil or water pollution or contamination.

The following horizontal separation distances are generally considered adequate where a significant layer of unsaturated, unconsolidated sediment less permeable than sand is encountered between ground surface and groundwater. These distances are based on present knowledge and past experience. Local conditions may require greater separation distances to ensure groundwater quality protection.

<table>
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<th>Potential Pollution or Contamination Source</th>
<th>Minimum Horizontal Separation Distance Between Well and Known or Potential Source</th>
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</thead>
<tbody>
<tr>
<td>Any sewer (sanitary, industrial, or storm; main or lateral)</td>
<td>50 feet</td>
</tr>
<tr>
<td>Watertight septic tank or subsurface sewage leaching field</td>
<td>100 feet</td>
</tr>
<tr>
<td>Cesspool or seepage pit</td>
<td>150 feet</td>
</tr>
<tr>
<td>Animal or fowl enclosure</td>
<td>100 feet</td>
</tr>
</tbody>
</table>

If the well is a radial collector well, minimum separation distances shall apply to the furthest extended point of the well.
Many variables are involved in determining the "safe" separation distance between a well and a potential source of pollution or contamination. No set separation distance is adequate and reasonable for all conditions. Determination of the safe separation distance for individual wells requires detailed evaluation of existing and future site conditions.

Where, in the opinion of the enforcing agency adverse conditions exist, the above separation distances shall be increased, or special means of protection, particularly in the construction of the well, shall be provided, such as increasing the length of the annular seal.

Lesser distances than those listed above may be acceptable where physical conditions preclude compliance with the specified minimum separation distances and where special means of protection are provided. Lesser separation distances must be approved by the enforcing agency on a case-by-case basis.

B. Gradients. Where possible a well shall be located up the groundwater gradient from potential sources of pollution or contamination. Locating wells up gradient from pollutant and contaminant sources can provide an extra measure of protection for a well. However, consideration should be given that the gradient near a well can be reversed by pumping, as shown in Figure 3, or by other influences.

C. Flooding and Drainage. If possible, a well should be located outside areas of flooding. The top of the well casing shall terminate above grade and above known levels of flooding caused by drainage or runoff from surrounding land. For community water supply wells, this level is defined as the:

"...floodplain of a 100 year flood..." or above "...any recorded high tide...",
(Section 64417, Sitting Requirements, Title 22 of the California Code of Regulations.)
If compliance with the casing height requirement for community water supply wells and other water wells is not practical, the enforcing agency shall require alternate means of protection.

Surface drainage from areas near the well shall be directed away from the well. If necessary, the area around the well shall be built up so that drainage moves away from the well.

D. **Accessibility.** All wells shall be located an adequate distance from buildings and other structures to allow access for well modification, maintenance, repair, and destruction, unless otherwise approved by the enforcing agency.
Section 9. Sealing the Upper Annular Space.

The space between the well casing and the wall of the drilled hole, often referred to as the annular space, shall be effectively sealed to prevent it from being a preferential pathway for movement of poor-quality water, pollutants, or contaminants. In some cases, secondary purposes of an annular seal are to protect casing against corrosion or degradation, ensure the structural integrity of the casing, and stabilize the borehole wall.

A. Minimum Depth of Annular Surface Seal. The annular surface seal for various types of water wells shall extend from ground surface to the following minimum depths:

<table>
<thead>
<tr>
<th>Well Type</th>
<th>Minimum Depth Seal Must Extend Below Ground Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community Water Supply</td>
<td>50 feet</td>
</tr>
<tr>
<td>Industrial</td>
<td>50 feet</td>
</tr>
<tr>
<td>Individual Domestic</td>
<td>20 feet</td>
</tr>
<tr>
<td>Agricultural</td>
<td>20 feet</td>
</tr>
<tr>
<td>Air-Conditioning</td>
<td>20 feet</td>
</tr>
<tr>
<td>All Other types</td>
<td>20 feet</td>
</tr>
</tbody>
</table>

1. Shallow groundwater. Exceptions to minimum seal depths can be made for shallow wells at the approval of the enforcing agency, where the water to be produced is at a depth less than 20 feet. In no case shall an annular seal extend to a total depth less than 10 feet below land surface. The annular seal shall be no less than 10 feet in length.

Caution shall be given to locating a well with a 'reduced' annular seal with respect to sources of pollution or contamination. Such precautions include horizontal separation distances greater than those listed in Section 8, above.

2. Encroachment on known or potential sources of pollution or contamination. When, at the approval of the enforcing agency, a water well is to be located closer to a source of pollution or contamination than allowed by Section 8, above, the annular space shall be sealed from ground surface to the first impervious stratum, if possible. The annular seal for all such wells shall extend to a minimum depth of 50 feet.

3. Areas of freezing. The top of an annular surface seal may be below ground surface in areas where freezing is likely, but in no case more than 4 feet below ground.
surface. 'Freezing' areas are those where the mean length of the freeze-free period described by the National Weather Service is less than 100 days. In other words, 'freezing' areas are where temperatures at or below 32 degrees Fahrenheit are likely to occur on any day during a period of 265 or more days each year. In general, these areas include:

- portions of Modoc, Lassen, and Siskiyou Counties;
- portions of the North Lahontan area including the eastern slope of the Sierra Nevada and related valleys north of Mount Whitney and Mono Lake; and,
- the area of Lake Arrowhead in the San Bernardino Mountains;

4. Vaults. At the approval of the enforcing agency, the top of an annular surface seal and well casing can be below ground surface where traffic or other conditions require, if the seal and casing extend to a watertight and structurally sound subsurface vault, or equivalent feature. In no case shall the top of the annular surface seal be more than 4 feet below ground surface. The vault shall extend from the top of the annular seal to at least ground surface.

The use of subsurface vaults to house the top of water wells below ground surface is rare and is discouraged due to susceptibility to the entrance of surface water, pollutants, and contaminants. Where appropriate, pitless adapters should be used in place of vaults.

B. Sealing Conditions. The following requirements are to be observed for sealing the annular space:

1. Wells drilled in unconsolidated, caving material. An 'oversized' hole, at least 4 inches greater in diameter than the outside diameter of the well casing, shall be drilled and a conductor casing temporarily installed to at least the minimum depth of annular seal specified in Subsection A, above. Permanent conductor casing may be used if it is installed in accordance with Item 3 and Item 5, below and if it extends at least to the depth specified in Subsection A, above. One purpose of conductor casing is to hold the annular space open during well drilling and during the placement of the well casing and annular seal.

Temporary conductor casing shall be withdrawn as sealing material is placed between the well casing and borehole wall, as shown in Figure 4A (Bulletin 74-81). Sealing material shall be placed at least within the interval specified in Subsection A, above. The sealing material shall be kept at a sufficient height

http://www.water.ca.gov/groundwater/well_info_and_other/california_well_standards/w... 04/20/2011
above the bottom of the temporary conductor casing as it is withdrawn to prevent caving of the borehole wall.

Temporary conductor casing may be left in place in the borehole after the placement of the annular seal only if it is impossible to remove because of unforeseen conditions and not because of inadequate drilling equipment, or if its removal will seriously jeopardize the integrity of the well and the integrity of subsurface barriers to pollutant or contaminant movement. Temporary conductor casing may be left in place only at the approval of the enforcing agency on a case-by-case basis.

Every effort shall be made to place sealing material between the outside of temporary conductor casing that cannot be removed and the borehole wall to fill any possible gaps or voids between the conductor casing and the borehole wall. At least two inches of sealing material shall be maintained between the conductor casing and well casing. At a minimum, sealing material shall extend through intervals specified in Subsection A, above.

Sealing material can often be placed between temporary conductor casing that cannot be removed and the borehole wall by means of pressure grouting techniques, as described below and in Appendix B (Bulletin 74-81). Other means of placing sealing material between the conductor casing and the borehole wall can be used, at the approval of the enforcing agency.

Pressure grouting shall be accomplished by perforating temporary conductor casing that cannot be removed, in place. The perforations are to provide passages for sealing material to pass through the conductor casing to fill any spaces and voids between the casing and borehole wall. Casing perforations shall be a suitable size and density to allow the passage of sealing materials through the casing and the proper distribution of sealing material in spaces between the casing and borehole wall. At a minimum, the perforations shall extend through the intervals specified in Subsection A, above, unless otherwise approved by the enforcing agency.

Temporary conductor casing that must be left in place shall be perforated immediately before sealing operations begin to prevent drilling or well construction operations from clogging casing perforations. Once the casing has been adequately perforated, sealing material shall be placed inside the conductor casing and subjected to sufficient pressure to cause the sealing material to pass through the conductor casing perforations and completely fill any spaces or voids between the casing and borehole wall, at least within the intervals specified in Subsection A, above. Sealing material shall consist of neat cement, or bentonite prepared from powdered bentonite and water, unless otherwise approved by the enforcing agency.

Sealing material must also fill the annular space between the conductor casing and the well casing within required sealing intervals.

2. Wells drilled in unconsolidated material with significant clay layers. An 'oversized' hole, at least 4 inches greater in diameter than the outside diameter of the well casing, shall be drilled to at least the depth specified in Subsection A, above, and the annular space between the borehole wall and the well casing filled with sealing
material in accordance with Subsection A, above (see Figure 4B, above). If a significant layer of clay or clay-rich deposits of low permeability is encountered within 5 feet of the minimum seal depth prescribed in Subsection A, above, the annular seal shall be extended at least 5 feet into the clay layer. Thus, the depth of seal could be required to be extended as much as another 10 feet. If the clay layer is less than 5 feet in total thickness, the seal shall extend through its entire thickness.

If caving material is present within the interval specified in Subsection A, a temporary conductor casing shall be installed to hold the borehole open during well drilling and placement of the casing and annular seal, in accordance with the requirements of Item 1, above. Permanent conductor casing may be used if it is installed in accordance with Item 3 and Item 5, below, and it extends to at least the depth specified in Subsection A, above.

3. Wells drilled in soft consolidated formations (extensive clays, sandstones, etc.). An 'oversized' hole, at least 4 inches greater than the outside diameter of the well casing, shall be drilled to at least the depth specified in Subsection A, above. The space between the well casing and the borehole shall be filled with sealing material to at least the depth specified in Subsection A, above, as shown by Figure 4C, above.

If a permanent conductor casing is to be installed to facilitate the construction of the well, an oversized hole, at least 4 inches greater in diameter than the outside surface of the permanent conductor casing, shall be drilled to the bottom of the conductor casing or to at least the depth specified in Subsection A, above, and the annular space between the conductor casing and the borehole wall filled with sealing material. In some cases, such as in cable tool drilling, it may be necessary to extend permanent conductor casing beyond the depth of the required depth of the annular surface seal in order to maintain the borehole. Sealing material is not required between conductor casing and the borehole wall other than the depths specified in Subsection A, above, and Section 13, below.

4. Wells situated in "hard" consolidated formations (crystalline or metamorphic rock). An oversized hole shall be drilled to the depth specified in Subsection A, above and the annular space filled with sealing material. If there is significant overburden, a conductor casing may be installed to retain it. If the material is heavily fractured, the seal should extend into a solid material. If the well is to be open-bottomed (lower section uncased), the casing shall be seated in the sealing
material (see Figure 5A).

5. Gravel packed wells.

a. *With conductor casing*. An oversized hole, at least 4 inches greater than the diameter of the conductor casing, shall be drilled to the depth specified in Subsection A, above and the annular space between the conductor casing and drilled hole filled with sealing material. (In this case the gravel pack may extend to the top of the well but to prevent contamination by surface drainage, a welded cover shall be installed over the top in the space between the conductor casing and the production casing, see Figure 3B).

b. *Without conductor casing*. An oversized hole at least 4 inches greater in diameter than the production casing, shall be drilled to the depth specified in Subsection A, above and the annular space between the casing and drilled hole filled with sealing material. If gravel fill pipes are installed through the seal, the annular seal shall be of sufficient thickness to assure that there is a minimum of 2 inches between the gravel fill pipe and the wall of the drilled hole. The gravel pack shall terminate at the base of the seal (see Figure 5C). If a temporary conductor casing is used, it shall be removed as the sealing material is placed.

6. For wells situated in circumstances differing from those described above, the sealing conditions shall be as prescribed by the enforcing agency.

7. Converted wells. Wells converted from one use to another, particularly those constructed in prior years without annular seals, shall have annular seals installed to the depth required in Subsection A, above and at the thickness described in Subsection E. Where it is anticipated that a well will be converted to another use, the enforcing agency may require the installation of a seal to the depth specified for community water supply wells.

8. Wells that penetrate zones containing poor-quality water, pollutants, or contaminants. If geologic units or fill known or suspected to contain poor-quality water, pollutants, or contaminants are penetrated during drilling, and, the possibility exists that poor-quality water, pollutants, or contaminants could move through the borehole during drilling and well construction operations and significantly degrade groundwater quality in other units before sealing material can be installed, then precautions shall be taken to seal off or 'isolate' zones containing poor-quality water, pollutants, and contaminants during drilling and well construction operations. Special precautions could include the use of temporary or permanent conductor casing, borehole liners, and specialized drilling equipment. The use of conductor casing is described in Item 1, above.

C. Conductor Casing. For community water supply wells, the minimum thickness of steel conductor casing shall be 1/4 inch for single casing or a minimum of No. 10 U. S. Standard Gage for double casing. Steel used for steel casing shall conform to the specifications for steel casing described in Section 12.
D. Sealing Material. Sealing material shall consist of neat cement, sand cement, concrete, or bentonite. Cuttings from drilling, or drilling mud, shall not be used for any part of the sealing material.

1. Water. Water used to prepare sealing mixtures should generally be of drinking water quality, shall be compatible with the type of sealing material used, be free of petroleum and petroleum products, and be free of suspended matter. In some cases water considered nonpotable, with a maximum of 2,000 milligrams per liter chloride and 1,500 mg/l sulfate, can be used for cement-based sealing mixtures. The quality of water to be used for sealing mixtures shall be determined where unknown.


Types of Portland cement available under ASTM C150 for general construction are:

Type I - General purpose. Similar to American Petroleum Institute Class A.

Type II - Moderate resistance to sulfate. Lower heat of hydration than Type I. Similar to API Class B.

Type III - High early strength. Reduced curing time but higher heat of hydration than Type I. Similar to API Class C.

Type IV - Extended setting time. Lower heat of hydration than Types I and III.

Type V - High sulfate resistance.

Special cement setting accelerators and retardants and other additives may be used in some cases. Special field additives for Portland cement mixtures shall meet the requirements of ASTM C494, Standard Specification for Chemical Admixtures for Concrete, and latest revision thereof.

Hydrated lime may be added up to 10 percent of the volume of cement used to make the seal mix more fluid. Bentonite may be added to cement-based mixes, up to 6 percent by weight of cement used, to improve fluid characteristics of the sealing mix and reduce the rate of heat generation during setting.

Dry additives should be mixed with dry cement before adding water to the mixture to ensure proper mixing, uniformity of hydration, and an effective and homogeneous seal. The water demand of additives shall be taken into account when water is added to the mix.

Minimum times required for sealing materials containing Portland cement to set and begin curing before construction operations on a well can be resumed are:
- Types I and II cement  □ 24 hours
- Type III cement  □ 12 hours
- Type V cement  □ 6 hours

Type IV cement is seldom used for annular seals because of its extended setting time.

Allowable setting times may be reduced or lengthened by use of accelerators or retardants specifically designed to modify setting time, at the approval of the enforcing agency.

More time shall be required for cement-based seals to cure to allow greater strength when construction or development operations following the placement of the seal may subject casing and sealing materials to significant stress. Subjecting a well to significant stress before a cement-based sealing material has adequately cured can damage the seal and prevent proper bonding of cement-based sealants to casing(s).

If plastic well casing is used, care shall be exercised to control the heat of hydration generated during the setting and curing of cement in an annular seal. Heat can cause plastic casing to weaken and collapse. Heat generation is a special concern if thin-wall plastic well casing is used, if the well casing will be subject to significant net external pressure before the setting of the seal, and/or if the radial thickness of the annular seal is large. Additives that accelerate cement setting also tend to increase the rate of heat generation during setting and, thus, should be used with caution where plastic casing is employed.

The temperature of a setting cement seal can be lowered by circulating water inside the well casing and/or by adding bentonite to the cement mixture, up to 6 percent by weight of cement used.

Cement-based sealing material shall be constituted as follows:

a. **Neat Cement.** For Types I or II Portland cement, neat cement shall be mixed at a ratio of one 94-pound sack of Portland cement 5 to 6 gallons of 'clean' water. Additional water may be required where special additives, such as bentonite, or 'accelerators' or 'retardants' are used.

b. **Sand Cement.** Sand-cement shall be mixed at a ratio of not more than 188 pounds of sand to one 94-pound sack of Portland cement (2 parts sand to 1 part cement, by weight) and about 7 gallons of clean water, where Type I or Type II Portland cement is used. This is equivalent to a '10.3 sack mix.' Less water shall be used if less sand than 2 parts sand per one part cement by weight is used. Additional water may be required when special additives, such as bentonite, or 'accelerators' or 'retardants' are used.

c. **Concrete.** Concrete is often useful for large volume annular seals, such as in large-diameter wells. The proper use of aggregate can decrease the permeability of the annular seal, reduce shrinkage, and reduce the heat of hydration generated by the seal.
Concrete shall consist of Portland cement and aggregate mixed at a ratio of at least six-94 pound sacks of Portland cement per cubic yard of aggregate. A popular concrete mix consists of eight-94 pound sacks of Type I or Type II Portland cement per cubic yard of uniform 3/8-inch aggregate.

In no case shall the size of the aggregate be more than 1/5 the radial thickness of the annular seal. Water shall be added to concrete mixes to attain proper consistency for placement, setting, and curing.

d. **Mixing.** Cement-based sealing materials shall be mixed thoroughly to provide uniformity and ensure that no 'lumps' exist.

Ratios of the components of cement-based sealing materials can be varied depending on the type of cement and additives used. Variations must be approved by the enforcing agency.

3. **Bentonite.** Bentonite clay in 'gel' form has some of the advantages of cement-based sealing material. A disadvantage is that the clay can sometimes separate from the clay-water mixture.

Although many types of clay mixtures are available, none has sealing properties comparable to bentonite clay. Bentonite expands significantly in volumes when hydrated. Only bentonite clay is an acceptable clay for annular seals.

Unamended bentonite clay seals should not be used where structural strength of the seal is required, or where it will dry. Bentonite seals may have a tendency to dry, shrink and crack in arid and semi-arid areas of California where subsurface moisture levels can be low. Bentonite clay seals can be adversely affected by subsurface chemical conditions, as can cement-based materials.

Bentonite clay shall not be used as a sealing material if roots from trees and other deep rooted plants might invade and disrupt the seal, and/or damage the well casing. Roots may grow in an interval containing a bentonite seal depending on surrounding soil conditions and vegetation.

Bentonite-based sealing material shall not be used for sealing intervals of fractured rock or sealing intervals of highly unstable, unconsolidated material that could collapse and displace the sealing material, unless otherwise approved by the enforcing agency. Bentonite clay shall not be used as a sealing material where flowing water might erode it.

Bentonite clay products used for sealing material must be specifically prepared for such use. Used drilling mud and/or cuttings from drilling shall not be used in sealing material.

Bentonite used for annular seals shall be commercially prepared, powdered, granulated, pelletized, or chipped/crushed sodium montmorillonite clay. The largest dimension of pellets or chips shall be less than 1/5 the radial thickness of the annular space into which they are placed.
Bentonite clay mixtures shall be thoroughly mixed with clean water prior to placement. A sufficient amount of water shall be added to bentonite to allow proper hydration. Depending on the bentonite sealing mixture used, 1 gallon of water should be added to about every 2 pounds of bentonite. Water added to bentonite for hydration shall be of suitable quality and free of pollutants and contaminants.

Bentonite preparations normally require 0 to 1 hour to adequately hydrate. Actual hydration time is a function of site conditions and the form of bentonite used. Finely divided forms of bentonite generally require less time for hydration, if properly mixed.

Dry bentonite pellets or chips may be placed directly into the annular space below water, where a short section of annular space, up to 10 feet in length, is to be sealed. Care shall be taken to prevent bridging during the placement of bentonite seal material.

E. **Radial Thickness of Seal.** A minimum of two inches of sealing material shall be maintained between all casings and the borehole wall, within the interval to be sealed, except where temporary conductor casing cannot be removed, as noted in Subsection B, above. A minimum of two inches of sealing material shall also be maintained between each casing, such as permanent conductor casing, well casing, gravel fill pipes, etc., in a borehole within the interval to be sealed, unless otherwise approved by the enforcing agency. Additional space shall be provided, where needed, for casings to be properly centralized and spaced and allow the use of a tremie pipe during well construction (if required), especially for deeper wells.

F. **Placement of Seal.**

1. **Obstructions.** All loose cuttings, or other obstructions to sealing shall be removed from the annular space before placement of the annular seal.

2. **Centralizers.** Well casing shall be equipped with centering guides or 'centralizers' to ensure the 2-inch minimum radial thickness of the annular seal is at least maintained. Centralizers need not be used in cases where the well casing is centered in the borehole during well construction by use of removable tools, such as hollow-stem augers.

   The spacing of centralizers is normally dictated by the casing materials used, the orientation and straightness of the borehole, and the method used to install the casing.

Centralizers shall be metal, plastic, or other non-degradable material. Wood shall not be used as a centralizer material. Centralizers must be positioned to allow the proper placement of sealing material around casing within the interval to be sealed.

Any metallic component of a centralizer used with metallic casing shall consist of the same material as the casing. Metallic centralizer components shall meet the same metallurgical specifications and standards as the metallic casing to reduce the potential for galvanic corrosion of the casing.
3. **Foundation and Transition Seals.** A packer or similar retaining device, or a small quantity of sealant that is allowed to set, can be placed at the bottom of the interval to be sealed before final sealing operations begin to form a foundation for the seal.

A transition seal, up to 5 feet in length, consisting of bentonite, is sometimes placed in the annular space to separate filter pack and cement-based sealing materials. The transition seal can prevent cement-based sealing materials from infiltrating the filter pack. A short interval of fine-grained sand, usually less than 2 feet in length, is sometimes placed between the filter pack and the bentonite transition seal to prevent bentonite from entering the filter pack. Also, fine sand is sometimes used in place of bentonite as the transition seal material.

Fine-sized forms of bentonite, such as granules and powder, are usually employed for transition seals if a transition seal is to be placed above the water level in a well boring. Coarse forms of bentonite, such as pellets and chips, are often used where a bentonite transition seal is to be placed below the water level.

Transition seals should be installed by use of a tremie pipe, or equivalent. However, some forms of bentonite may tend to bridge or clog in a tremie pipe.

Bentonite can be placed in dry form or as slurry for use in transition seals. Water should be added to the bentonite transition seal prior to the placement of cement-based sealing materials where bentonite is dry in the borehole. Care should be exercised during the addition of water to the borehole to prevent displacing the bentonite.

Water should be added to bentonite at a ratio of about 1 gallon for every 2 pounds of bentonite to allow for proper hydration. Water added to bentonite for hydration shall be of suitable quality and free of pollutants and contaminants.

Sufficient time should be allowed for bentonite transition seals to properly hydrate before cement-based sealing materials are placed. Normally, ☐ to 1 hour is required for proper hydration to occur. Actual time of hydration is a function of site conditions.

The top of the transition seal shall be sound to ensure that no bridging has occurred during placement.

4. **Timing and Method of Placement.** The annular space shall be sealed as soon as practical after completion of drilling or a stage of drilling. In no case shall the annular space be left unsealed longer than 14 days following the installation of casing.

Sealing material shall be placed in one continuous operation from the bottom of the interval to be sealed, to the top of the interval. Where the seal is more than 100 feet in length, the deepest portion of the seal may be installed first and allowed to set or partially set. The deep initial seal shall be no longer than 10 feet in length. The remainder of the seal shall be placed above the initial segment in one continuous operation.
Sealing material shall be placed by methods (such as the use of a tremie pipe or equivalent) that prevent freefall, bridging, or dilution of the sealing material, or separation of sand or aggregate from the sealing material. Annular sealing materials shall not be installed by freefall unless the interval to be sealed is dry and no deeper than 30 feet below ground surface.

5. *Groundwater Flow.* Special care shall be used to restrict the flow of groundwater into a well boring while placing material, where subsurface pressure causing the flow of water is significant.

6. *Verification.* It shall be verified that the volume of sealing material placed at least equals or exceeds the volume to be sealed.

7. *Pressure.* Pressure required for placement of sealing materials shall be maintained long enough for cement-based sealing materials to properly set.