California Groundwater Association

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CGA STANDARD PRACTICE SERIES

ARTICLE 299 – DESTRUCTION OF WATER WELLS

BACKGROUND

GENERAL

With increasing concern over trace quantities of contaminants affecting the quality of ground water, the potential for inactive or "abandoned" wells to act as pathways for contaminants into groundwater becomes more critical. Although Bulletins 74-81 and 74-90 contain general guidelines as to materials and procedures to be followed in the destruction of wells, there have been advances in technology and sealing materials since Bulletin 74-90 was issued. Further, in considering destruction procedures we now need to eliminate potential contamination from organic contaminants such as MTBE that were not even identified as such when the bulletins were prepared.

Therefore, the purpose of this standard is to provide guidance, based on current industry practice, on the type and application of sealing materials, and techniques used in the physical process of well destruction that are not covered, or depart from, those specified in Bulletin 74. As with Article 580 of the CGA Standard Practice Series on the Destruction of Test or Exploration Holes, another purpose of this standard is to provide guidance where local jurisdictional agencies may rely on Bulletin 74 as a reference for their requirements for well destruction.

The definition of an "abandoned" well, and the time limits after which a well should be destroyed are contained in Section 115700 (d) the California Health and Safety Code, which states:

"A "permanently inactive well" is a well that has not been used for a period of one year, unless the person owning land in fee simple or in possession thereof under lease or contract of sale demonstrates an intent for future use for water supply, groundwater recharge, drainage, or groundwater level control, heating or cooling, cathodic protection, groundwater monitoring or related uses."

Requirements for *"demonstrating an intent for future use"* are included in the Code.

DISCUSSION

BASIC CONCEPTS

If destruction is properly accomplished, the well is no longer a conduit for surface water contamination, cross-contamination of water of differing quality into multiple aquifers, and the pressure head in the aquifer(s) is preserved. If vertical movement of water within the well bore, including the annular space, is prevented, then the objective for destruction of the well is achieved. An open well (particularly the large diameter "hand dug" variety) that presents a safety hazard is mitigated by the destruction process. Applicable destruction methods and materials as discussed in this Standard will depend on the specific reason for destroying the well and on its condition and construction details.

For effective destruction procedures, the hydrogeologic setting of the well should be considered. For example, in water-table conditions, the main consideration is sealing the well with impermeable

materials to prevent downward movement of surface water into the well from the top of the casing, or along the annular space. In a confined or artesian situation, sealing must prevent loss of pressure and/or return of water to the surface, or into a dry "thief" zone, or into a zone of less pressure head.

PRE-DESTRUCTION ACTIVITIES

The importance of obtaining specific hydrogeologic and well construction data increases with the complexity of well construction and the risk of aquifer contamination from known nearby sources. If a driller's log, geophysical log, and construction data are available, these would be the primary sources of data to be consulted. However, for many old wells this type of information is not available.

Static water levels and well depths can be directly measured. Well construction details, such as placement of screens, can be determined by a downhole video survey, and other logs such as natural gamma, cement bond, casing inspection, and fluid conductivity, can be completed in the well, to address specific local concerns (ie., flowing wells; threat of contamination) that may dictate destruction procedures.

Any obstructions in the casing, such as debris, pumps, or junk should be removed, to the original total depth of the well, if known. It should be recognized that in some instances, such as in attempts to recover an old pump that has dropped to the bottom of the well or where casing has collapsed, such efforts may not be successful and the clearing of obstructions shall be required only to the extent possible. Additionally, the well should be pumped or bailed to clean any suspected foreign fluids, such as turbine oil, from the water column to the extent possible.

RECOMMENDATIONS

The California Groundwater Association recommends adopting the following on materials and procedures for the proper destruction of wells, as presented in this Article and summarized on the accompanying Well Destruction Flow Chart.

SEALING MATERIALS

Sealing materials provide a "water-tight" barrier to migration of water and any associated contaminants in the well bore. Recommended sealing materials per Bulletin 74-81/90 include: neat cement, sand-cement, bentonite, or combinations of these materials. In some cases, additives are used to affect viscosity, setting time, and strength. It should be noted that make-up water chemistry may be important in determining the ultimate behavior of the sealing materials during placement and curing. The water quality of the make-up water should be checked before operations begin to ensure that the water is compatible with the sealing materials.

Neat cement grout: Neat cement grout generally involves using a ratio of one 94-lb. Bag of Portland cement to no more than 6-1/2 gallons of water (which is equal to a 17-sack cement/water mix as available from a "ready-mix" source). A small amount of bentonite (up to 6 percent) may be added to make the mixture more "fluid" and reduce shrinkage. Special additives may need to be used in the mix to prevent deterioration of the cement column in areas subjected to sea-water intrusion, for example.

Sand-cement mixtures: Sand-cement mixtures increase the "bulk" and might be used in such situations as filling a large-diameter hand-dug well. The recommended mixture is generally 2 parts sand to 1 part Portland cement by weight and about 7 gallons of water.

High solids sodium bentonite: This type of "sealing grade" grout consists of 20 to 30 percent solids content by weight of sodium bentonite when mixed with water. Pumping in place is necessary for this bentonite, to

lower the viscosity, and generally higher pumping pressures are needed than normally used with cement grout.

Bentonite chips: These grout products, commonly known as "Hole Plug", or medium and coarse Enviroplug, are intended to be poured into the well to form a seal. The materials readily absorb water and form a very low permeability and permanent seal. Being denser than water they can be poured through standing water.

Other materials for filling: In cases where no sealant is needed to prevent water flow and materials are only needed to fill the well, coarse sand or gravel may be employed. These materials should be clean and not contaminated, and of a particle size which minimizes the potential for "bridging" during placement.

SEALING OPERATIONS

Casing Destruction

Well destruction operations performed prior to or simultaneously with the sealing of cased wells may involve pulling any existing casing out of the ground as applicable and/or feasible, or perforating or other means used to cause openings in the casing large enough fo the sealing material to pass into the borehole. Openings in the casing may be made with an air-percussion perforator, ripped with a mechanical knife or similar device, or destroyed using explosives. In some situations where it is not possible to remove the casing or the casing is too deteriorated to use perforating tools, explosives are an acceptable alterative. Some of these situations include PVC casing, wells with liners, wells with physical restrictions (e.g., breaks, ovals, drop pipes, etc.) and wells with deteriorated casings.

Placement

The appropriate sealing materials are placed from the bottom of the well up, using a tremie pipe which is kept submerged in the mixture and is periodically raised as the well bore is filled in one continuous operation. However, special situations may dictate two or more stages. Some applications may call for pressure grouting. In some deep wells where lost circulation of cement into the formation behind the casing might result (or actually occurs) from the fracture gradient of the formation being exceeded, use of additives that lighten the mixture, and emplacement in a minimum of two "stages" may be necessary. With any sealing method, the volume of the hole to be filled should be calculated, and compared with the volume of sealing materials used, to be sure that the volume of materials emplaced is at least equal to the hole volume.

Casing Destruction Using Explosives

Blasting work in water wells requires a C-57 water well contractor license and the blaster must hold a current CAL-OSHA license for blasting water wells. The California State License Board (CSLB) licenses Drilling. Blasting, and Oil Field Work under specialty classifications C-61 contractors with D-09 classifications does not include water well work or drilling. The "Blaster in Charge" is in control at the blast site. He is responsible for the safety of the explosive products used, product placement, and blast design.

Sealing material should always be placed in the well prior to initiating the casing destruction process with explosives. This routine prevents the possibility of casing pieces and other debris from flying out of the well creating a potentially dangerous situation while the subsequent caving and/or sloughing prevents proper placement of the sealing material. When the sealing materials are placed in the well, the blast simultaneously opens the casing and pushes (pressure grouts) the sealing material into the annulus and borehole. Oilfield practices utilizing gun and jet perforating use products that contaminate are not allowed in water wells.

Cable Tool or Other Casing Driven Wells

Typically, wells drilled by the cable tool method do not have a concrete annular seal, but may have an outer casing seated in an "impervious" layer, with a telescoped smaller diameter inner casing with no gravel pack extending into the production zone(s). In the case of old agricultural wells, perforations may extend nearly to the surface, serving as a potential pathway for entry of near-surface contamination.

Considering the above, the best method of destruction is extracting the casing(s) and at same time introducing the sealing material from the bottom of the well to the top. If not possible, or the casing fails during extraction, then perforating and sealing operations should be completed as described under the section Casing Destruction, with special attention to placing openings for sealing opposite "impervious" layers. Considerations in sealing "flowing" artesian cable-tool drilled wells are discussed below.

Hard-Rock Wells With Surface Casing Only

In some wells, surface casing may only extend to a shallow depth, with open hole to total depth. After confirming that the well has and effective surface annular seal, it is recommended that the well should be filled with clean materials as defined previously in this Article up to a depth of 10 feet in native formation below the bottom of the existing casing (60 feet in this example). Appropriate sealing materials should then be placed from the top of the fill material to the surface. In no case should there be less than 20 feet of sealing material, starting in native formation 10 feet below the bottom of an existing casing. If the well has no surface annular seal, it may be necessary to overbore the casing and tremie in a seal, or to extract the casing entirely while a seal is tremied into place.

Multi-Aquifer Wells

The overriding concern in sealing wells that contain multiple aquifers is to permanently prevent the exchange of water from one aquifer to another, particularly in areas where wells penetrate aquifers containing differing water quality, or where one aquifer may be contaminated. Generally, sealing material is introduced into the well bore through perforations opposite "impervious" layers as interpreted from examination of driller's logs, geologist's logs, and geophysical logs, such as natural gamma-ray and video surveys that can be run in a cased hole where formation and well construction information is lacking. More detailed pre-destruction evaluation may be needed than normally employed for other types of wells. Local regulatory agencies may dictate exact procedures for the sealing of certain aquitards or "impervious" layers in well destruction, and for example, may require pressure grouting through existing perforations, or mechanical perforating of the blank casing.

Flowing Wells

Effective sealing of flowing wells, particularly those having relatively high flows from a large diameter casing, may be difficult to accomplish. One of the main problems is to reduce or eliminate the flow to the extent possible before destruction operations begin. For low flow from small wells, pumping the well, or extending the casing upward may eliminate the flow, allowing sealing to proceed. An inflatable packer may be installed in a larger diameter well, and cement grout pumped in below it with "accelerators" used to facilitate a rapid "set".

However, particularly in old cable-tool wells, or in larger diameter rotary-drilled wells where the surface seal is not particularly effective, setting a casing packer may only add to the problem, as water flow is now diverted to the outside of the casing. In this situation, one remedy is to pressure grout the outside of

the casing with a volume of cement at least 4 x the volume of the casing itself, to form an effective outer seal. Then, the operation of pressure grouting below a packer inside the casing should be successful and not cause leakage from the annular space around the outside of the casing.

Destruction of PVC Casing in Place

Mechanical perforators generally do not work in PVC casing, and drilling out the PVC casing and accompanying seal is probably the most effective method of destruction. The drilling (using a reaming and long pilot bit) needs to be done slowly to avoid deflection and plugging of the bit with PVC chips. Alternative methods, as discussed previously, might involve use of explosives. The explosives are professionally set at selected intervals, the well is then filled with sealing material, and the explosives are set off. This process drives the sealing material into the annulus and the borehole wall. Remnants of PVC casing left in place are not considered to be a hazard to water quality.

Monitoring Wells

Although much of the information contained in this Article is applicable to small-diameter (eg. 2-inch and 4-inch) monitoring wells, this well category is excluded from consideration, for the reason that much detailed information on well destruction exists elsewhere. Detailed standards for monitoring well construction and destruction are contained in Bulletin 74-90, which should be referred to. In addition, the ASTM Book of Standards, Designation D 5299-92, 1993, should be consulted (see References), as well as the California Department of Toxic Substances Control series of well guidance documents.

Large Diameter Hand-Dug Wells

Open, large diameter hand-dug wells not only present a pathway for groundwater contamination, but provide a physical hazard to persons or animals that may fall in. These wells may involve large volumes of fill and sealing materials, and may present other unusual problems in their destruction. Sometimes there are small-diameter "laterals" at the bottom of such wells as used in the radial collector type of construction, that must be dealt with for effective destruction. Occasionally, there is a drilled well extending from the bottom of the hand dug well, constructed when water levels dropped below the lift of a shallow centrifugal pump, and this bored well at the bottom must be destroyed first.

As much of the lining should be removed as possible, consistent with safety concerns, with particular attention paid to the upper 5 feet of "curbing", so as to assure to the extent possible good contact of the upper sealing material with native materials of the well. If the well is dry, or can be pumped dry, clean backfill materials as previously described, can be used to fill the well up to 20 feet below the surface (or a shallower depth as applicable) at which point, sealing material should be placed to the surface or just below the "plowing" depth, with an accompanying concrete cap. If the well contains water, then cement or bentonite grout should be placed from the bottom of the well to several feet above the water level, followed by fill material to 5 feet below the surface, and in turn covered by a concrete "cap" extending to the surface, or below "plowing" depth.

SURFACE CONSIDERATIONS

Excavation for "Mushroom" Cap

Specifications for well destruction in urban areas may call for the removal of the top of the casing to a depth of 5 feet below the ground surface and construction of a concrete "mushroom" cap. Old wells that have been "sand pumpers" may have a cavity surrounding the top of the well, and excavation for a

"mushroom cap" may be hazardous to the safety of personnel and equipment. For this reason, the "mushroom" cap is not safe or necessary in most situations. Safety regulations require shoring of excavations deeper than 5 feet. Extreme safety precautions should be used around an excavation of this kind if the "mushroom" cap is to be poured, as experience indicates that soil in the annulus around the casing may be unstable. Cutting off the casing at a lesser depth than 5 feet may be warranted in such a situation, along with emplacement of sealing material to a minimum depth of 20 feet. With this treatment, the "mushroom" cap is not recommended.

Disposal of Fluids and Solids

Disposal of fluids and solids resulting from well destruction operations should be accomplished in accordance with applicable local and regional ordinances and regulations relative to "Best Management Practices (BMP)".

RECORDS

Records of the materials and well destruction procedures are normally required by regulatory agencies, and their requirements should be adhered to. It is always useful to survey the location using a GPS system, so that a location of a destroyed well may be recovered if a problem of contamination (for example) should arise in the future. This is especially true in areas of special concern or contamination. Possibly, a method of visual identification such as a marker or ID tag that could be placed at the well location (or above it, if top of casing is below ground) would be useful in recovering the location at a later date.

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SELECTED REFERENCES

WELL DESTRUCTION STANDARDS

ASTM Book of Standards, 1993: Standard guide for decommissioning of ground-water wells, vadose zone monitoring devices, boreholes, and other devices for environmental activities, Designation D5299-92 p. 163-178.

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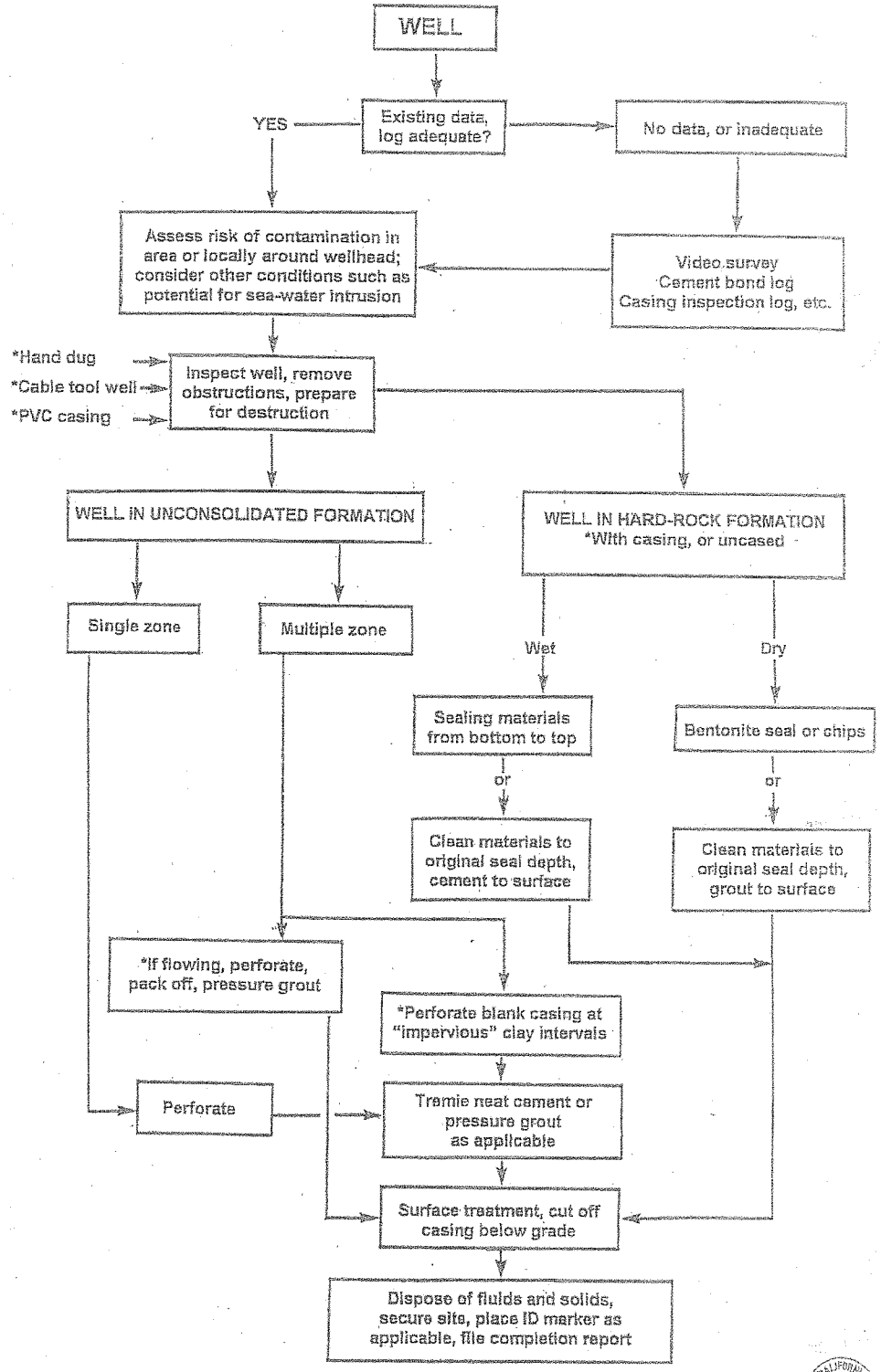
WELL DESTRUCTION FLOW CHART



*See Applications: Specific Situations

Accompanies CGA Standard Practice Series: Destruction of Water Wells

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