

# Casing Liners for Large-Diameter Water Wells: An Approach to Repair Damaged Steel Casing or Screen

## BACKGROUND

It is not uncommon for large-diameter water wells to suffer some damage during their operational lifetime as a result of various down-hole procedures (e.g. redevelopment) or exposure to natural ground-water conditions. Among the more common after effects of well damage are corrosion and sanding; both conditions can seriously affect the continued use of an otherwise productive well. In some cases, depending upon the severity of the well's condition, it may become necessary to reduce the pumping rate in order to control the problem somewhat. In the worst case, the well might have to be abandoned. However, two other options for consideration are: 1) complete relining, and 2) installing a partial liner.

This memorandum describes a general approach for pre-design planning, liner selection, and liner installation. It would be prudent to note within these introductory remarks that there is no one, single solution that will meet the requirements of every type of well repair project. Therefore, the information provided herein is intended to serve as a primer for those who might be interested in the use of well liners.

## ASSESSMENT PHASE

The objective of the assessment phase is to gather and evaluate pertinent, background information on the affected (i.e., impaired) well. This phase is intended to provide the information needed to decide whether the well can be repaired and should be repaired. It should also provide information needed to determine how best to repair the well. Therefore, this phase should ultimately yield much more than a simple go/no-go decision.

Typical background information for the assessment phase might include (but is not limited) to the following:

- Well specifications (if available)
- As-built well design
- Historic production records
- Annotated records of the owner and/or operator(s)
- Down-hole video(s) - A well video is a high-priority item for the well assessment. If a recent well video has not been made or is unavailable, a video survey should be conducted.
- Historic pumping test results
- Rehabilitation records
- Other - Some damaged wells pump appreciable quantities of sand that pass through enlarged openings in the well screen and/or blank casing. Samples of the sand should be collected during the assessment phase and analyzed in a laboratory to determine the size range of the sediment. A sieve analysis, conducted by a geotechnical laboratory, will provide information that can be used in the design phase of the project.

## DESIGN AND INSTALLATION

### Complete Relining

A relined well consists of an inner casing that extends from ground level (with an appropriate stick-up, if needed) to the bottom of the existing well casing. Generally, the outside diameter (OD) of the liner is on the order of 3 to 4 inches smaller than the inside diameter (ID) of the existing casing. Various materials such as mild steel, copper-bearing steel, high-strength low alloy steel, and stainless steel are suitable for liners, depending upon the parameters of strength and durability that are required for specific installation.

A typical complete liner includes a section of blank casing (i.e., pump chamber) that is connected to one or more sections of louvered screen or continuous wire-wrapped screen. This memorandum assumes that the well screen in the outer casing and liner are located at the bottom of the well. Often, the annular space between the liner and outer casing/screen is filled with select gravel. If a gravel pack is installed in the annular space, the apertures (i.e., slots) of the inner well screen are sized to retain 100 percent of the gravel pack material.

Installing a liner can be an effective way to deal with a structural problem in the well and might add many years to its lifetime. However, the liner can negatively impact the well's pumping capacity because of the added well losses. Also, there is the possibility that the smaller ID of the liner might make it impossible to re-install the pump that was previously used in the well. Therefore, a new pump may be needed to meet the new physical and hydraulic conditions of the well.

### Partial Liners

A partial liner is a section of casing that is secured in place within the well by various methods. Two types of commonly-used, partial liners are discussed below.

#### *Swaged Liner*

A swaged liner is a short section of casing and/or screen that essentially functions as a patch. This type of liner is installed typically with either an electric or hydraulic swage. Electric swages are used to install corrugated steel or other thin-walled steel liners, whereas annealed steel liners are installed with a hydraulic swage. The installation procedure consists of lowering the swage and liner into position at the appropriate depth. Then, the swage is activated. It enlarges within the casing and forcibly shapes and affixes the liner to the interior of the casing. The swage is then removed from the well.

#### *Drop-Off Liner*

A drop-off liner typically consists of a length of either louvered or wire-wrapped screen that is installed at the bottom of the well. The liner is attached to a tool on the end of a string of drill pipe. After the liner is in place, the attachment between the liner and drill pipe is uncoupled, leaving the liner behind. The annular space between the drop-off liner and casing/screen can be filled with selected gravel. The liner installation may be completed by grouting around the top of the liner through a temporary tremie pipe.

## PERFORMANCE TESTING

When the new liner is in place, the well should be pump tested to determine its production capacity, drawdown, and specific capacity. These data will be needed to select the appropriate pumping equipment and to plan the continued use of the well.

## SUMMARY

Relining a well or installing a partial liner can be effective options to remediate some structural problems that occur within blank casing and/or well screen of large-diameter water wells. The effectiveness of either option depends, in part, on the type and severity of the specific well problem. Therefore, those two factors should be carefully considered during the assessment phase of the project.

Also, before deciding to install a liner, one should realize that the production capacity of the well may be significantly affected. We contacted various well owners and conducted an informal, non-scientific survey on the effect of liners on pumping capacity. We found that some well owners reported no significant change, whereas others reported up to a 50 percent reduction in capacity. It appears that the myriad factors that influence production capacity (e.g., well design, length of screen, aquifer transmissivity) make it impossible to accurately predict the well's response. Therefore, for planning purposes, one could reasonably assume that as a worst-case scenario a fully relined well might lose up to 50 percent of its original production capacity. If this level of performance is unacceptable, perhaps another option should be considered.

Finally, it should be noted that complete liners and partial liners should be thought of as methods for "temporary repair". It would be prudent to assume that the liner will allow one to operate the impaired well for a "short" time until a permanent solution (e.g., replacement well, alternative water source, etc.) is selected and implemented.

## REFERENCES

*Handbook of Ground Water Development*, 1990, Roscoe Moss Company, John Wiley and Sons, New York, NY.