USACE ST. LOUIS DISTRICT LEVEE SAFETY PROGRAM

STANDARD OPERATING PROCEDURE: INSPECTION, MAINTENANCE AND MECHANICAL REHABILITATION OF RELIEF WELLS

1.0 INSPECTION OF RELIEF WELLS

1.1 General. Relief wells are in place to provide underseepage relief during high water events. They accomplish this by tapping into the substratum, and provide pressure relief in a controlled manner, with low flow resistance and prevent uncontrolled piping and erosion of the foundation soils.

Well construction is essentially the same from the ground surface to the total depth. Wells are constructed with a riser pipe (solid pipe) and screened sections. Screened sections are sometimes interspersed with blanks, to block out layers unacceptable for screening. The well construction material types that could be encountered are creosote-impregnated wood stave, PVC, mild steel and stainless steel.

Wells installed between 1950-1970 are generally constructed of creosote-impregnated wood stave risers and screens. Wells constructed in the 1970s thru the 1980s will have either PVC or mild steel as their construction materials. Finally, wells constructed in the 1990s to present, utilized stainless steel risers and screened sections as the construction material. It is important to know which type of material was used in the construction of the wells to select the correct pump test method and mechanical rehabilitation to use, should it become necessary.

Relief wells shall be pump tested to determine the specific capacity of the well (gpm/drawdown) on a risk-based frequency, not to exceed a 5-10 year basis, as determined by St. Louis District Levee Safety in collaboration with the nonfederal sponsor. Loss of specific capacity indicates loss of open area in the well and gravel pack. This loss increases the pressure gradient during high water events and this can cause uncontrolled piping and erosion in the foundation soils.

1.2 Inspection. Relief wells should be kept free of sand, silt, organic matter, or any other material that will retard free flow. Particular attention should be directed to inspecting the condition of the neoprene or rubber gaskets on the underside of the checkvalves and on top of the wood-stave tenon, depending upon construction materials. Deterioration, damage or loss of these gaskets could result in the well being damaged by back flooding of muddy water.

The inspection of the relief well shall include a report of the general exterior condition of the relief well, noting any problems with discharge flow away from the well, and any damage or missing parts to the outlet works, tees, manholes and any remediation of these problems. A photo of the exterior of the well, with a placard showing the levee district name, relief well number, and approximate station or state-plane coordinates, should be included in the inspection. An example inspection report is included as Attachment 1 to this Standard Operating Procedure (SOP).

1.3. Reporting of data should be sent to CEMVS-EC, Levee Safety, 1222 Spruce Street, St. Louis, MO 63103 or Rachel.l.lopez@usace.army.mil.

2.0 PUMP TESTING PROCEDURE FOR CREOSOTE-IMPREGNATED WOOD STAVE WELLS

2.1 General. Prior to any pumping or other down well activity, all wood stave wells shall be treated for free standing creosote by the use of a low-flow, closed loop filtration and washing system. This low flow, closed loop filtration system is owned by the Government and arrangements can be made for the utilization of this equipment by your approved pumping Contractor or through a task order via the St. Louis District Professional Services Contracts. Costs for the utilization of this equipment or Contract and appropriate disposal of the filtration media should be incorporated into the estimate and will be determined on a case by case basis.

The Contractor shall provide an accurate means for determining the water level in the wells to the nearest 0.10-foot. The use of a weighted tape shall not be regarded as sufficiently accurate for such measurement. The groundwater levels shall be no less than 10-foot above the top of the well screen to ensure a valid pump test can be performed. No pump testing shall be performed concurrently on any other relief well within a 500-foot radius.

2.1.1 Personal Protection and Safety. As a minimum, personnel handling the equipment, water lines, hoses, pumps and supplies shall wear latex or rubber gloves, eye protection and sleeve protection. The Contractor shall take precautions prior to entering any confined space with oxygen-depleted environments. Regulations for OSHA 29CFR1910 and U.S. Army Corps of Engineers Safety Manual, EM 385-1-1 entitled 'Safety and Health Requirements Manual', which are applicable to this work, shall be observed and complied with. The Contractor shall conduct weekly safety meetings with all personnel to assure compliance with these requirements.

2.2 Equipment

2.2.1 Pumps. Only deep well submersible pumps shall be used for this pump testing. Pump set-up shall include all equipment necessary to power the pump and direct discharge away from the well and prevent ponding at the well for the duration of the test. The pumps shall be capable of producing 500 gallons per minute flow from the wells with static water levels as low as 25-foot below ground surface. The pump used shall be capable of maintaining uninterrupted flow for up to 2 hours.

2.2.2 Flow Meters. The Contractor shall furnish and install the required flow meters when discharging water during the pump test. Flow meters shall be of standard rotating propeller design, compatible with the pumps and water lines, or approved alternative. All flow meters shall be calibrated prior to the commencement of work, and any time the Contractor or the Government has reason to suspect inaccuracy.

2.2.3 Rossum Sand Tester. The Contractor shall use the Rossum Sand Content Tester to evaluate and record the amount of sand and/or material being pumped from the well, in parts per million. The sample shall be collected in the discharge line while the water is in turbulent flow. The sample shall be collected according to the manufacturer's directions. The flow rate through the tester shall be checked during each run. If the flow rate is not as specified by the manufacturer, the test shall be repeated. There shall be a minimum of three readings per two-hour pump test.

2.3 Procedure. Following the low flow cleanout of the wood stave well, the Contractor shall measure and record the depth of each well prior to and following each pump test. If the total depth measurement indicates that there is debris in the well, of less than 20% of the screen length, it shall be removed by bailing or airlifting, to within 2 feet of the installed depth. If there is more than 20% of the screen length covered by debris in the well, the Contractor shall record the data and not perform any further work. This data should be reported with the pump test data, back to the St. Louis District..

Following the bottom cleanout, the Contractor shall install the submersible pumps and start the test by pumping continuously for up to 2 hours at up to the maximum constant discharge rate of 500 gallons per minute or if the drawdown in the pumped well reaches 10-foot. Pumping rate shall be held constant and testing continued until drawdown is stabilized, but at no time shall the drawdown exceed 10-feet. At no time shall the well screen be exposed during pumping.

The pumping rate may be reduced as needed, to meet the drawdown and screen exposure requirements, but shall not be less than 300 GPM. If the 300-500 GPM range cannot be met, the Contractor shall terminate the pump test, and record the data and provide the report, back to the St. Louis District.

All discharge shall be directed over the top of the levee and the pipe shall be terminated in a saxophone discharge. Minimum 4 mil thickness plastic shall be placed under the terminus to prevent erosion of the levee slope.

Wells which show a loss of specific capacity of more than 85% of original, shall have a mechanical rehabilitation procedure performed, in an attempt to increase the specific capacity to 85-100% of original

2.4. Reporting. The relief well inspection, pumping test, cleanout and sand infiltration test data shall be reported on the forms following this SOP and a summary tabulation of results of the work shall be provided.. See paragraph 1.3 above. An example pumping test report is included as Attachment 2.

3.0 PUMP TESTING FOR PVC, MILD STEEL AND STAINLESS STEEL WELLS

3.1 General. The Contractor shall provide an accurate means for determining the water level in the wells to the nearest 0.10-foot. The use of a weighted tape shall not be regarded as sufficiently accurate for such measurement. The groundwater levels shall be no less than 10-foot above the top of the well screen to ensure a valid pump test can be performed. No pump testing shall be performed concurrently on any other relief well within a 500-foot radius.

If the total depth measurement indicates that there is debris in the well, of less than 20 % of the screen length, it shall be removed by bailing or airlifting, to within 2 feet of the installed depth. If there is more than 20% of the screen length covered by debris in the well, the Contractor shall record the data and not perform any further work. This data should be reported, in addition to the pump test data, back to the St. Louis District..

3.2 Equipment.

3.2.1 Pumps. Only deep well submersible pumps shall be used for this pump testing. Pump set-up shall include all equipment necessary to power the pump and direct discharge away from the well and prevent ponding at the well for the duration of the test. The pumps shall be capable of producing 700 gallons per minute flow from the wells with static water levels as low as 25-foot below ground surface. The pump used shall be capable of maintaining uninterrupted flow for up to 2 hours.

3.2.2 Flow Meters. The Contractor shall furnish and install the required flow meters when discharging water during the pump test. Flow meters shall be of standard rotating propeller design, compatible with the pumps and water lines, or approved alternative. All flow meters shall be calibrated prior to the commencement of work, and any time the Contractor or the Government has reason to suspect inaccuracy.

3.2.3 Rossum Sand Tester. The Contractor shall use the Rossum Sand Content Tester to evaluate and record the amount of sand and/or material being pumped from the well, in parts per million. The sample shall be collected in the discharge line while the water is in turbulent flow. The sample shall be collected according to the manufacturer's directions. The flow rate through the tester shall be checked during each run. If the flow rate is not as specified by the manufacturer, the test shall be repeated. There shall be a minimum of three readings per two-hour pump test.

3.3 Procedure. The Contractor shall measure and record the depth of each well prior to and following each pump test. If the total depth measurement indicates that there is debris in the well, of less than 20% of the screen length, it shall be removed by bailing or airlifting, to within 2 feet of the installed depth. If there is more than 20% of the screen length covered by debris in the well, the Contractor shall record the data and not perform any further work. This data should be reported with the pump test data, back to the St. Louis District.

Following the bottom cleanout, the Contractor shall install the submersible pumps and start the test by pumping continuously for up to 2 hours at up to the maximum constant discharge rate of 700 gallons per minute or if the drawdown in the pumped well reaches 10-foot. Pumping rate shall be held constant and testing continued until drawdown is stabilized, but at no time shall the drawdown exceed 10-feet. At no time shall the well screen be exposed during pumping.

The pumping rate may be reduced as needed, to meet the drawdown and screen exposure requirements, but shall not be less than 300 GPM. If the 300-700 GPM range cannot be met, the Contractor shall terminate the pump test, and record the data and provide the report, back to the St. Louis District.

All discharge shall be directed over the top of the levee and the pipe shall be terminated in a saxophone discharge. Minimum 4 mil thickness plastic shall be placed under the terminus to prevent erosion of the levee slope.

Wells which show a loss of specific capacity of more than 85% of original, shall have a mechanical rehabilitation procedure performed, in an attempt to increase the specific capacity to 85-100% of original

3.4. Reporting. The relief well inspection, pumping test, cleanout and sand infiltration test data shall be reported on the forms following this SOP and a summary tabulation of results of the work shall be provided to the St. Louis District - See Paragraph 1.3, above.

4.0 MECHANICAL REHABILITATION OPTIONS

4.1 General. Well rehabilitation is periodically required during the life of a well, as groundwater contains bacteria and minerals which cause well plugging. Screens, gravel pack and formations may become blocked, reducing the capacity and efficiency of the well. There are several options for mechanical rehabilitation of the wells, which may breakup, or loosen biofouling or mineral incrustation, thereby improving the capacity and efficiency of the well. Mechanical rehabilitation can be an aggressive procedure and should only be undertaken by experienced well personnel. Any single or combination of mechanical rehabilitation methods may be used to treat wells.

Periodically during the mechanical rehabilitation, a total depth measurement shall be taken. This is to confirm that the well screen has not been breached or damaged and to ensure the filter pack or aquifer is not impacting the total depth of the well. If at any time, the Contractor is concerned that damage to the well has occurred, all work shall cease, all data shall be recorded and the St. Louis District shall be notified immediately.

Following any mechanical rehabilitation, a total depth measurement should be taken. Any debris brought into the well by this action, should be removed by airlifting or bailing. In addition, a post-rehab pump test should be run, to gauge the effectiveness of the mechanical rehabilitation. The post-rehabilitation pump test shall conform to the requirements as specified in 2.3, 2.4 and 3.3 and 3.4, above.

4.2 Pump surging. Pump surging is an easy option to attempt. The pump is already in the well from the initial pump test and no additional equipment is necessary. Pump surging consists of pumping at varying rates from maximum to minimum to create the greatest amount of water surge in the well. Maximum should be no more than the maximum flow attempted during the initial pump test on that particular well, as specified in 2.3 and 3.3 above. Pump surging can be applied for up to 2 hours in a well.

4.3 Brushing. Brushing of the interior of the well, from the riser thru the screened sections is often employed as a ‘pre’ treatment to mechanical rehabilitation. Brushing consists of attaching a stiff poly or nylon brush to drill pipe or surge block and brushing the interior of the well. It is recommended that brushing be accomplished in small sections, to ensure thorough cleaning of the interior of the well. On 8-inch diameter, wood stave wells, it is recommended that the brush diameter be no more than 7-inches. There are other diameters available for larger diameter wells, or for more aggressive brushing in mild steel and stainless wells. Brushing can be employed prior to any of the other mechanical rehabilitation methods described below.

4.4 Surge Block. The surge block method works similarly to the pump surge method, but applies the surging action to a particular section of well screen at a time. This method is typically combined with brushing of the interior of the well with a stiff nylon brush, usually attached to the bottom of the surge block.

The surge block shall be operated by equipment capable of varying speeds over the full depth of the wells. The equipment shall be capable of traversing and maintaining the velocity of surge block travel in the wells at a rate between 1 to 1-1/2 feet per second in both down and up direction.

The following description for a surge block is appropriate for 8-inch diameter, wood stave wells: the surge block shall consist of two-groups of neoprene rubber circular disks spaced 4 feet apart and held in place by washers and spacers. Each group of disks shall consist of a 1-inch thick, 7-inch diameter rubber disk, with a 1-inch thick, 5-inch diameter rubber disk on either side. This combination of rubber disks shall be fixed between rigid washers 2-1/2- to 3-1/2-inches in diameter. The entire assembly shall be rigidly fastened to the end of a drill stem or pipe of sufficient mass to cause it to fall free on the downward stroke. The disks shall be replaced whenever they become worn, or after every fourth well that has been surged with a given set of rubber disks. A solid surge block shall not be used.

Determine the depths to the screen section to be treated, usually between 5-10 foot in length. The surge block shall be allowed to free fall through the screened section being treated. At no time shall the surge block be allowed to free-fall and strike the bottom of the well. The surge block shall then be raised to its original position. Repeat for a period of 30 minutes and for each treated section of screen.

Wells which show a loss of specific capacity of more than 85% of original, and that do not respond to mechanical rehabilitation procedure performed, shall be scheduled for replacement and shall be monitored to ensure well screen and filter pack remains in place until such time that it can be replaced. Wells scheduled for replacement shall be included in the report cited below.

4.6 Reports. The mechanical rehabilitation, and pre- and post- pumping test shall be reported on the forms included as Attachment 3 of this SOP and a summary tabulation of results of the work shall be provided to the St. Louis District - See Paragraph 1.3 above.

__________________________________Levee System
RELIEF WELL INSTPECTION DATA SHEET

RELIEF WELL NO. ____________ STATION_____________________ OFFSET____________

If no station/offest given, provide gps lat/long reading. Photograph number: _______________

AS BUILT DEPTH__________________ MEASURED DEPTH_____________________

RELIEF WELL TYPE (CIRCLE ONE) M(manhole) D (vertical discharge) T (tee discharge)

RELIEF WELL OUTLET CONDITIONS:	(remarks)
Missing/Damaged bolts ____ of ____	
Missing/Damaged washers ____ of ____	

GENERAL CONDITIONS:	(remarks)
Easily accessible Y N	
Good condition Y N	
Good rust protection Y N	
Good drainage around the well Y N	

CONDITION OF VERTICAL DISCHARGE				CHECK APPLICABLE BLOCK (√)		
ITEM	N/A	Good	Fair	Poor	Missing	comment
Lid						
Screen						
Standpipe						
Checkvalve						
Checkvalve gasket						

CONDITION OF HORIZONTAL (TEE) DISCHARGE				CHECK APPLICABLE BLOCK (√)		
ITEM	N/A	Good	Fair	Poor	Missing	comment
Lid						
Flapgate						
T-stub						

REMARKS

(DATE)	(INSPECTOR)

Attachment 2

RELIEF WELL PUMPING TEST REPORT

LEVEE SYESTEM: ______________________ **DATE:** ____________

RELIEF WELL NO.: ____________

LOCATION (STA. OR SPCS)

AS-BUILT INFO: **TOP OF RISER (EL):** ____________ **Total Depth of Well (FT)** ____________

TOP OF SCREEN (EL): ____________ **TOP OF SCREEN (FT bgs_:** ____________

BOTTOM OF WELL (EL): **BOTTOM OF WELL (FT bgs:**

OBSERVATION INFO:

INITIAL WATER LEVEL: ______________________ **STATIC water level**

MEASUREMENT TAKEN AT: ______________________ **Typically top of riser**

Remarks: ______________________

Time					Time					Discharge Rate		
Since Test Began	Time of Day (Ex: 9:30 am)	water level	draw-down	Sanding Rate ml/L	Since Test Began	Time of Day	water level	draw-down	Sanding Rate ml/L			
0 Sec			0		13					Time	flow-meter	Discharge rate
15					14							
30					15							
45					20							
60 Sec / 1 Min					25							
75					30							
90					35							
105					40							
120 Sec / 2 Min					45							
2.5 Min					50							
3					60 Min / 1 Hr							
3.5					70							
4					80							
4.5					90 Min / 1.5 Hr							
5					100 Min							
6					120 Min/2 Hr							
7					150 Min/2.5 Hr							
8					180 Min/3 Hr							
9					210 Min/3.5 Hr							
10					240 Min/4 Hr							
11					270 Min/4.5 Hr							
12					300 Min/5 Hr							

Legend:

Water Level and Drawdown in decimal Feet **Required Rossum reading;** all others are optional **bgs: below ground surface**

Discharge Rate in gpm

Sanding Rate in ml/L

Attachment 3

MECHANICAL REHABILITATION DATA

Levee System: ____________________ | Well #: ____________ | Date: ____________________

Location (STA): | As Built depth to top of screen: | As-Built inside depth of well:

Surge / Int. Pump	Cycle Number	Depth of Screen Inteval	Start Time	Finish Time	Depth to Well Bottom	Comments