WELL DECOMMISSIONING
ON THE LUMMI INDIAN RESERVATION
DURING 2006

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1. INTRODUCTION

The Lummi Indian Reservation (Reservation) is located along the Western Boundary of Whatcom County in the northwestern part of Washington State (Figure 1). Ground water is the primary source for domestic, commercial, municipal, and industrial potable water supplies on the Reservation. Individual water supply wells (wells) that served one to a few homes and/or facilities were the primary source of water supply prior to the formation of the Lummi Water District in the 1970s. Over time, many of these wells have been abandoned as the Lummi Water District provided water to homes and other facilities.

Contamination of Reservation ground water is one of the three potential nonpoint source impairments identified in the Lummi Nation Nonpoint Source Management Plan (LWRD 2002). Abandoned wells that are not properly decommissioned could lead to direct contamination of ground water through conveyance of pollutants associated with storm water or through other means. Decommissioning of wells is consistent with actions identified in the Lummi Nation Nonpoint Source Management Plan to address saltwater intrusion into Reservation aquifers (see Table 3.6 in LWRD 2002) and contamination of Reservation ground water (see Table 3.4 in LWRD 2002).

The Lummi Natural Resources Department (LNR) obtained a grant from the U.S. Environmental Protection Agency (EPA) to decommission abandoned water supply wells on the Reservation (Assistance Identification No. BG-97042601-3).

This report is a summary of well decommissioning conducted during the 2006 calendar year. This document is organized into six sections and has two appendices. This first section is the introduction, the second section describes the methods, the third section presents the results, the fourth section discusses the overall well decommissioning effort, the fifth section contains the conclusions, and the sixth section lists the cited reference. Appendix A contains the results of the evaluations performed on each well to determine if the well should be decommissioned, and Appendix B contains the Water Well Decommissioning Reports completed by B&C for each decommissioned well.

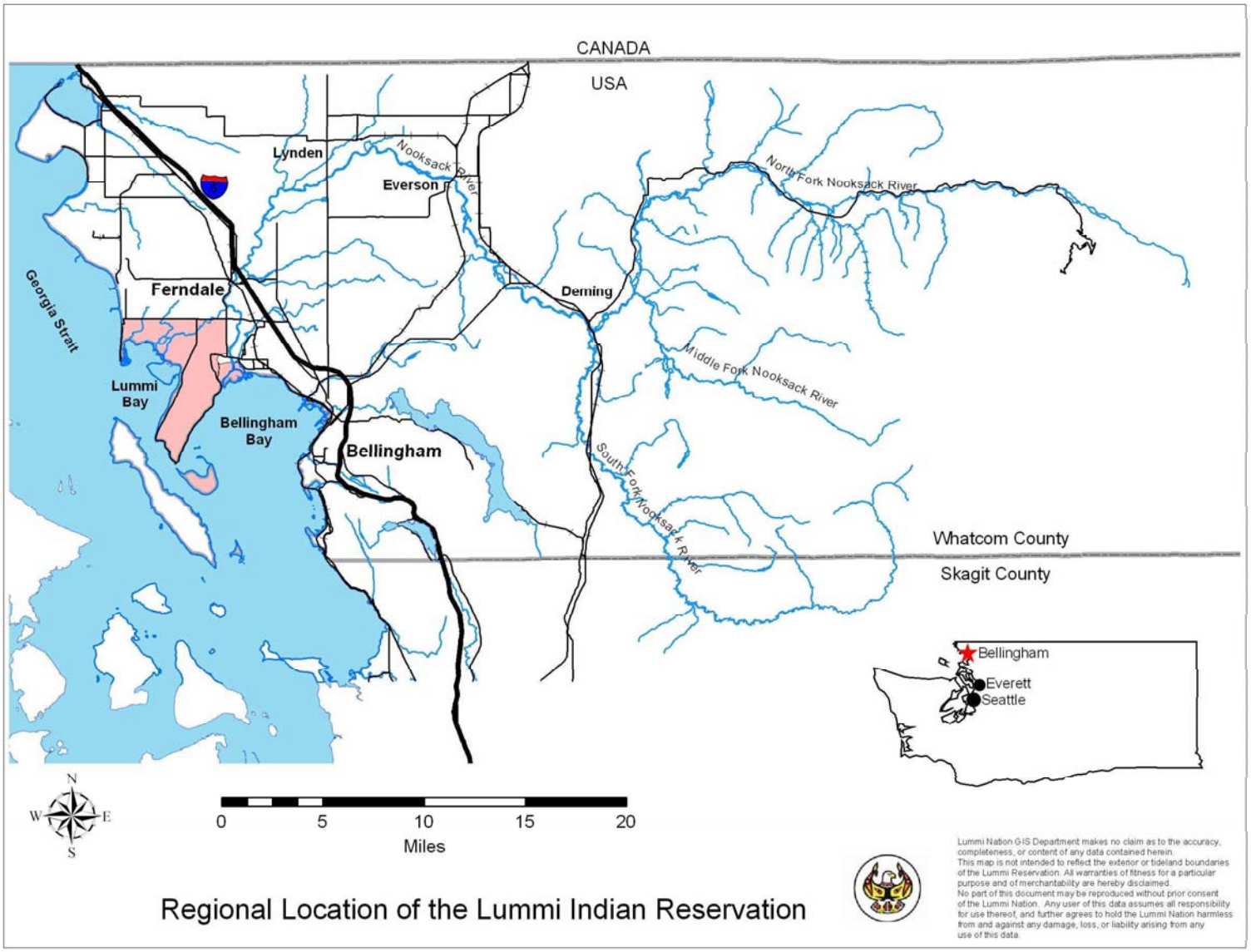

Figure 1. Regional location of the Lummi Indian Reservation.

2. METHODS

Contractors were used to conduct the well decommissioning activities. During the summer of 2006, the Lummi Water Resources Division (LWRD) solicited competitive bids for decommissioning wells on the Reservation. After the first solicitation resulted in only one responsive bid, a second solicitation was issued. Following a review of the submitted proposals, the company B&C Well Drilling, Inc. (B&C) was selected to perform the decommissioning. Salix Environmental Services (Salix) had been contracted previously by the LWRD to provide water resources management and planning services and was tasked with providing logistical support, coordination, and documentation of the well decommissioning work performed by B&C.

The approach to decommissioning water wells consisted of 1) identifying candidate wells, 2) evaluating each candidate well against criteria to determine if the well should be a monitoring well or decommissioned, and 3) decommissioning of selected wells.

During the fall of 2006, 22 candidate wells were selected and evaluated. Of the 22 wells initially identified, eight appeared feasible candidates for decommissioning during 2006. Reasons that wells were not considered feasible for decommissioning during 2006 included wells that were not abandoned, could not be located on-the-ground, could not be reasonably accessed during the wet-season, and one well that was involved in settlement of an estate. This initial evaluation was led by Salix and guided by Victor Solomon (Supervisor, Lummi Water District) and Jeremy Freimund (Water Resources Manager, LWRD). The eight selected wells were then evaluated to determine if the wells should be decommissioned or used as monitoring wells. These evaluations indicated that each of the wells should be decommissioned. Appendix A contains the results of the evaluations.

As part of the well decommissioning activities, permission was obtained from all well owners to decommission their wells, and well locations were evaluated in the Lummi Nation Geographic Information System (GIS). The GIS evaluation consisted of comparing locations indicated by various methods (e.g., surveys) against high resolution (6-inch), ortho-rectified aerial photographs (Pictometry). As a result, six of the eight wells selected for decommissioning were precisely located with a mapping-grade Global Positioning System (GPS) by Gerry Gabrisch (GIS Technician, LNR).

As the Lummi Nation has not yet adopted well decommissioning regulations, the well decommissioning procedures described in the Washington Administrative Code (WAC) Chapter 173-160 were implemented for the selected wells. The Water Resources Manager reviewed and approved the methods for decommissioning of the eight selected wells. In general, drilled wells were decommissioned by removing all obstructions, perforating the casing, then placing a bentonite slurry from the bottom of the well to the top, followed by cutting the top of the casing off several feet below the ground surface and filling the area immediately over the well with topsoil. At least several days passed between the filling of wells with bentonite and the removal of the upper portion of the casing, which allowed for placement of additional bentonite, if the bentonite had settled in the well after the initial placement. Dug wells were decommissioned by

removing obstructions, removing the water, placing concrete in the well to a few feet below the ground surface, removing the upper few feet of casing, and filling the area immediately over the well with native soil. Figures 2 through 6 are pictures of the various steps of decommissioning a drilled well (they are not all of the same well).

Figure 2. Removal of the pump and associated plumbing from a well.

(a)

(b)

Figure 3. Well perforation operation (a) and the perforation tool (b).

Figure 4. Placement of bentonite slurry.

Figure 5. Removal of the top of the casing below the ground surface.

(a)

(b)

Figure 6. Burial of decommissioned well (a) and final grade (b).

3. RESULTS

Although eight wells were selected for decommissioning (Table 1, Figure 7, Appendix A), seven wells were decommissioned during 2006. Well No. 89 was not decommissioned due to delays associated with logistics (e.g., equipment problems, poor weather) that precluded conducting and completing the work before December 31, 2006.

This section provides summary documentation for each of the seven decommissioned wells. Appendix B contains the Water Well Decommissioning Reports completed by B&C for each decommissioned well.

Table 1. List of wells selected to be decommissioned.

Lummi No.	TRS Code	Well Decommissioned?	Located with Mapping-Grade GPS?
46	38N/01E-13J02	YES	YES
48	38N/02E-19L03	YES	YES
49	38N/02E-19L04	YES	YES
68	38N/02E-30D03	YES	NO
87	37N/01E-02E03	YES	YES
89	37N/01E-02M03	NO	YES
95	37N/01E-02Q04	YES	YES
130	37N/01E-02P02	YES	NO

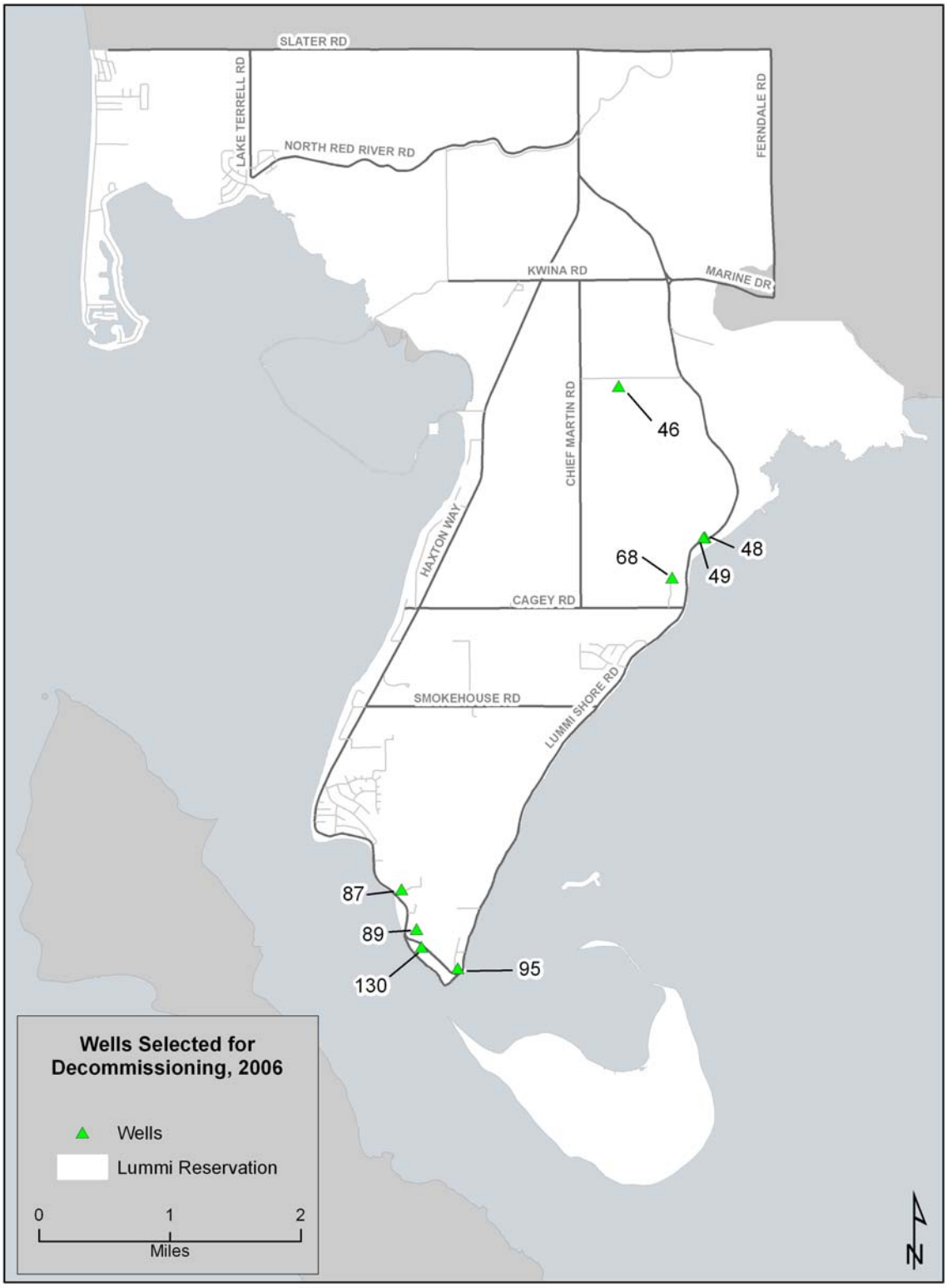

Figure 7. Locations of wells selected for decommissioning in 2006 on the Lummi Indian Reservation.

3.1. Well No. 46

Well No. 46 is located at 2581 Scott Road and is behind a day care facility. The well was decommissioned because it was in an area vulnerable to contamination from nearby homes (Appendix A). The Well Decommissioning Report (Appendix B) documents the decommissioning of the well. The land surface elevation in the Well Decommissioning Report is approximate and based on use of a tape measure. Figure 8 shows the well before and after decommissioning.

The well was a former public water supply for a church, which was transferred to the Lummi Indian Business Council in December 1996 and subsequently converted to a day care facility. During the course of decommissioning this well, the neighbor (Ms. Lucy Spencer) stated that based on a survey conducted in recent years, the well was on her property rather than on the LIBC/daycare property. The Lummi Planning Department confirmed this survey and that the well was located on the property owned by Ms. Spencer. After explaining why permission had been obtained from the Day Care facility (aerial photographs and parcel mapping indicated that the well was on the Day Care facility property), why her permission had not been sought prior to starting the decommissioning process, apologizing for the error, and explaining the purpose of the well decommissioning effort, Ms. Spencer granted permission to complete the well decommissioning. The corrected well ownership information is reflected in the Well Decommissioning Report (Appendix B), but was not known at the time of the evaluation to determine if the well should be decommissioned (Appendix A).

No problems with the well were encountered during decommissioning. The pump and associated piping were removed and salty-looking deposits were observed in the pump pipe immediately above the submersible pump. The casing was perforated from 6’ (about 5’ below ground surface) to the top of the screen, after which the well was filled from the bottom to the top with bentonite slurry. Several days later, the casing was cut-off 3 feet below the ground surface and the area immediately over the well covered with topsoil.

(a)

(b)

Figure 8. Well No. 46 before (a) and after (b) decommissioning. The well was located inside of the pumphouse engulfed in blackberries.

3.2. Well No. 48

Well No. 48 is located at 3411 Lummi Shore Road and was decommissioned because it was abandoned and vulnerable to contamination (Appendix A). The well was located immediately adjacent to a garage. The Well Decommissioning Report (Appendix B) documents the decommissioning of the well. The land surface elevation in the Well Decommissioning Report is approximate and based on use of a tape measure. Figure 9 shows the well before and after decommissioning.

No problems were encountered during the decommissioning of the well. The well was pumped dry, followed by the removal of the pump and associated materials, and the upper most concrete tile (casing material). The well was filled with concrete to one foot below the ground surface and the area immediately over the well filled with topsoil.

(a)

(b)

Figure 9. Well No. 48 before (a) and after (b) decommissioning.

3.3. Well No. 49

Well No. 49 is located at 3411 Lummi Shore Road and was decommissioned because it was abandoned and vulnerable to contamination (Appendix A). The well was located close to a house and a large maple tree. The Well Decommissioning Report (Appendix B) documents the decommissioning of the well. The land surface elevation in the Well Decommissioning Report is approximate and based on use of a tape measure. Figure 10 shows the well before and after decommissioning.

No problems were encountered during the decommissioning of the well. The well was pumped dry, followed by the removal of the pipes (no wires or pump present), and the two upper most concrete tiles (casing material). The well was filled with concrete to one foot below the ground surface and the area immediately over the well filled with topsoil.

(a)

(b)

Figure 10. Well No. 49 before (a) and after (b) decommissioning.

3.4. Well No. 68

Well No. 68 is located at 3292 Lighting Bird Lane. This well was decommissioned because it was abandoned and located in an area that is vulnerable to contamination (Appendix A). Two new homes are located close to the well. The well was abandoned due to the appearance of a black scale-like material in the well water. In addition, the well had elevated chloride levels. The Well Decommissioning Report (Appendix B) documents the decommissioning of the well. Figure 11 shows the well before and after decommissioning.

The measured depth of the well was 141 feet, which is 6 feet shallower than the depth indicated on the well log. This may have been due to the probe becoming stuck on the screen (the screened interval is 140 to 145 feet). The entire length of the casing was not perforated due to problems encountered during the decommissioning. The apparent cause was infilling of the well with formation materials (i.e., materials outside of the well) entering the well through the perforations. The perforating tool was unable to descend in the well beyond a depth of about 120 feet, which is 21 feet above the measured bottom of the well. The remainder of the casing (120 feet) was fully perforated. The determination was made that the lack of perforation near the bottom of the well, and the apparent infilling of the bottom of the well would not compromise protection of aquifer. Bentonite slurry was placed from 120 feet to the top of the well. The bentonite slurry settled in the casing (i.e., the top of the bentonite slurry dropped from the top of the casing to about 30 feet below the top of the casing). This upper portion of the casing was then refilled to the surface with bentonite slurry. Many days later, the casing then was cut-off 3 feet below the ground surface and the area immediately over the well filled with topsoil.

(a)

(b)

Figure 11. Well No. 68 before (a) and after (b) decommissioning.

3.5. Well No. 87

Well No. 87 is located below the Wexliem Community Center. This well was decommissioned because it was abandoned and located in an area that is vulnerable to vandalism (Appendix A). The well is located close to a K-12 School in an area screened by vegetation. The Well Decommissioning Report (Appendix B) documents the decommissioning of the well. Figure 12 shows the well before and after decommissioning.

This well was not perforated prior to the placement of bentonite in the well. The well was located in a stand of large Western Red Cedar trees, which would have been extensively damaged by the access road and well drilling equipment that would have been needed, if the well were perforated. It is highly unlikely that the ground in the immediate area of the well will ever be disturbed. It was determined that placement of bentonite in the well with a secondary seal at the top of the cut-off casing would protect the aquifer from potential contamination. Only the bottom 40 feet of the well was filled with bentonite slurry due to problems with the bentonite slurry pump. The remainder of the well was filled with unhydrated bentonite chips that were hand-placed. Many days later, the casing was then cut-off 3 feet below the ground surface and a secondary seal was placed at the top of the cut-off well. Placement of the secondary seal consisted of placing bentonite over and around the top of the cut-off casing (Figure 13). During the removal of the top portion of the casing, an existing surface seal in satisfactory condition was observed. Finally, the area immediately above the well was filled with topsoil.

(a)

(b)

Figure 12. Well No. 87 before (a) and after (b) well decommissioning. The shovel is located over the decommissioned well.

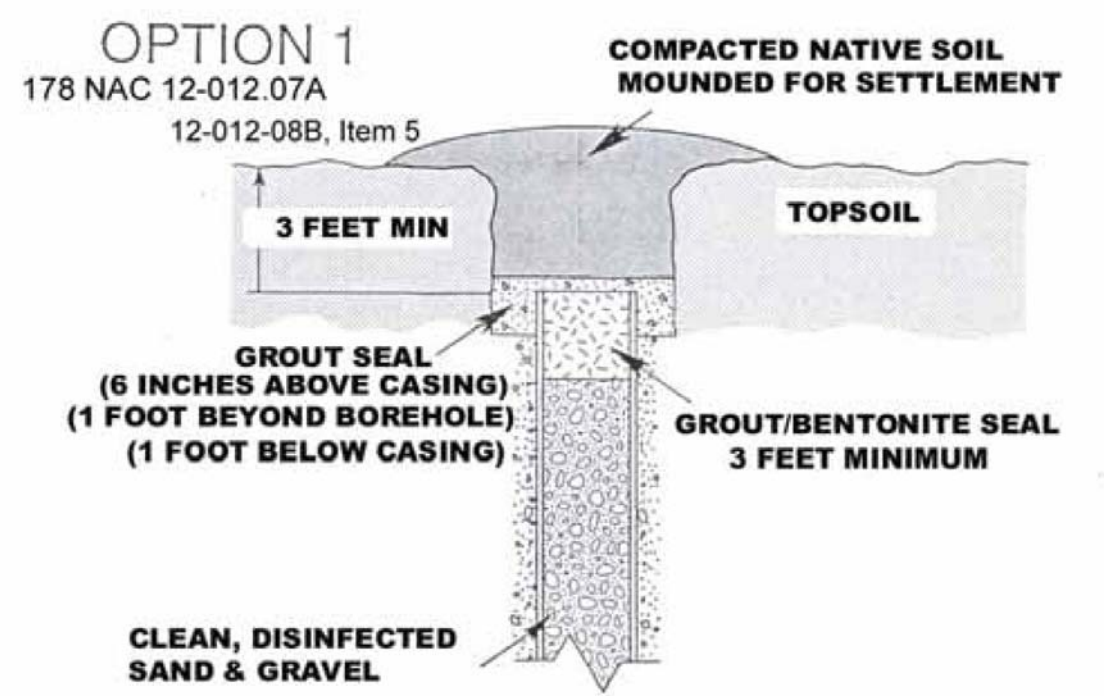

Figure 13. The "Grout Seal" above is the "secondary seal" that was utilized at Well No. 87 (from Nebraska Health and Human Services, Title 178, Chapter 12, Figure 11).

3.6. Well No. 95

Well No. 95 is located 2101 Lummi Shore Road. This well was decommissioned because it was abandoned and located in an area that is vulnerable to contamination (Appendix A). The well was located adjacent to a garage at the end of a driveway. The Well Decommissioning Report (Appendix B) documents the decommissioning of the well. The land surface elevation in the Well Decommissioning Report is approximate and based on use of a tape measure. Figure 14 shows the well before and after decommissioning.

The entire length of the casing was not fully perforated due to problems encountered during the decommissioning. The apparent cause was the casing breaking at a welded joint. The bottom 14 feet of the well (from 40 to 54 feet) was partially perforated. The remainder of the well casing from 14 feet above the screen to the land surface (40 feet) was fully perforated. The determination was made that the lack of complete perforation near the bottom of the well would not comprise protection of aquifer. Bentonite slurry was placed from the bottom to the top of the well. Many days later, the casing was cut-off 2.5 feet below the ground surface and the area immediately over the well filled with topsoil.

(a)

(b)

Figure 14. Well No. 95 before (a) and after (b) well decommissioning. Inset in (a) is close-up of well inside protective concrete collar.

3.7. Well No. 130

Well No. 130 is located at the Gooseberry Sewer Treatment Plant and was decommissioned because it was abandoned and in a vulnerable location (Appendix A). An office building and parking lot were placed close to the well. The Well Decommissioning Report (Appendix B) documents the decommissioning of the well. Figure 15 shows the well before and after decommissioning.

The entire length of the casing was not perforated due to problems encountered during the decommissioning of the well. The apparent cause was infilling of the well with formation materials (i.e., materials outside of the well) entering the well through the perforations. These materials caused the perforating tool to be inoperative near the bottom of the well, and filled the bottom 9 feet of the well. Approximately 23 feet of casing above the screen was not perforated, and the interval from 23 to 43 feet above the screen was partially perforated. The remainder of the casing from 43 feet above the screen to the land surface (140 feet) was fully perforated. The determination was made that the lack of perforation near the bottom of the well, and the apparent infilling of the bottom of the well would not compromise protection of aquifer. Bentonite slurry was placed from 181 feet to the top of the well. The bentonite slurry settled in the casing (i.e., the top of the bentonite slurry dropped from the top of the casing to about 35 feet below the top of the casing). This upper portion of the casing was then refilled with bentonite chips. Many days later, the casing was cut-off 2 feet below the ground surface and the area immediately over the well filled with topsoil.

(a)

(b)

Figure 15. Well No. 130 before (a) and after (b) well decommissioning.

4. DISCUSSION

Overall, the well decommissioning effort conducted during 2006 was successful. Seven wells were decommissioned, removing potential sources of contamination to Reservation aquifers. Another benefit of the well decommissioning effort was increasing community awareness about protecting ground water. Well decommissioning is not a subtle activity and many individuals inquired about both how wells are decommissioned and why wells are decommissioned.

The 2006 well decommissioning effort was the first of its kind on the Reservation. Many lessons were learned, including:

- Conduct the decommissioning during the dry season. In addition to easier site access, the chance of weather that can shut down operations (e.g., extended freezing periods, large snowfalls) is reduced.
- Allow extra time for problems, particularly with older wells. In one instance, the casing apparently broke at a joint, which made perforating the remaining casing take more time.
- Perforate wells from bottom to top. Formation materials can enter through perforations and accumulate in the bottom of the well. It may not be possible to purge these materials from the bottom of the well. Accumulated material at the bottom of the well may also preclude the ability to perforate the casing at the bottom of the well.
- Perforation of the casing in areas where surrounding sediments are saturated can lead to heaving of materials into the well.
- Prediction of the amount of bentonite slurry needed to fill a well is difficult due to the apparent flow of the slurry out of the screen and perforations (more bentonite was always required). As amended December 22, 2006, Chapter 173-160 of the Washington Administrative Code allows for placement of unhydrated bentonite chips in the screen, which may reduce the amount of bentonite slurry used. Well drillers from other jurisdictions also indicated that placement of unhydrated bentonite chips in the screen is effective.
- Bentonite slurry will settle in a well after placement (i.e., the top of the bentonite column will fall within the well). Allow time for stabilization of the bentonite (refilling as necessary) prior to cutting the casing off below ground level and burial of the well.

5. CONCLUSION

Seven wells were decommissioned on the Reservation in 2006. Wells are a potential source of contamination to Reservation aquifers. Well decommissioning is a direct and effective method to eliminate potential contamination of Reservation aquifers. Additional wells remain to be decommissioned. The well decommissioning program should be continued.

6. REFERENCE

Lummi Water Resource Division (LWRD). 2002. Nonpoint Source Management Plan. Bellingham, WA.

APPENDIX A. WELL DECOMMISSIONING EVALUATIONS

APPENDIX B. INDIVIDUAL WELL DECOMMISSIONING REPORTS