



Static Water Levels and Completion Details of Nested Piezometers in the Quaternary-Tertiary(?) Succession, Athabasca Oil Sands (In Situ) Area, Alberta



**Static Water Levels and
Completion Details of Nested
Piezometers in the
Quaternary-Tertiary (?)
Succession, Athabasca Oil
Sands (In Situ) Area, Alberta**

T.G. Lemay and G. Jean

Alberta Geological Survey

December 2002

©Her Majesty the Queen in Right of Alberta, 2002

The Alberta Energy and Utilities Board/Alberta Geological Survey (EUB/AGS) and its employees and contractors make no warranty, guarantee or representation, express or implied, or assume any legal liability regarding the correctness, accuracy, completeness, or reliability of this publication. Any digital data and software supplied with this publication are subject to the licence conditions (specified in 'Licence Agreement for Digital Products'). The data are supplied on the understanding that they are for the sole use of the licensee and will not be redistributed in any form, in whole or in part, to third parties. Any references to proprietary software in the documentation, and/or any use of proprietary data formats in this release, do not constitute endorsement by the EUB/AGS of any manufacturer's product.

If this product is an EUB/AGS Special Report, the information is provided as received from the author and has not been edited for conformity to EUB/AGS standards.

When using information from this publication in other publications or presentations, due acknowledgment should be given to the EUB/AGS. The following reference format is recommended:

Lemay, T.G. and Jean, G. (2002): Static water levels and completion details of nested piezometers in the Quaternary-Tertiary (?) succession, Athabasca Oil Sands (in situ) Area, Alberta; Alberta Energy and Utilities Board, EUB/AGS Geo-Note 2002-08.

Published December 2002 by:

Alberta Energy and Utilities Board
Alberta Geological Survey
4th Floor, Twin Atria Building
4999 – 98th Avenue
Edmonton, Alberta
T6B 2X3

Tel: (780) 422-3767 (Information Sales)

Fax: (780) 422-1918

Web site: www.ags.gov.ab.ca

Contents

Acknowledgmentsiv
Abstract.....v
1 Introduction1
2 Study Area1
3 Test Hole Details, Piezometer Completion and Water-Level Information1
 3.1 Site WR 99-11
 3.2 Site WEPA 00-14
 3.3 Site WEPA 00-34
4 Comment on Vertical Gradients at the Piezometer Sites4
5 Conclusions4

Tables

Table 1 Monthly water level elevations in metres above sea level, November 2000 – November 20017
Table 2 Calculated Vertical Gradients.....15

Figures

Figure 1 Study area map2
Figure 2 Location map of AGS piezometers3
Figure 3 Water-table well-construction details: WR 99-1-8(WT)5
Figure 4 Piezometer-construction details: WR 99-1-2306
Figure 5 Water-table construction details: WEPA 00-1-15(WT)8
Figure 6 Piezometer-construction details: WEPA 00-1-419
Figure 7 Piezometer-construction details: WEPA 00-1-76.....10
Figure 8 Piezometer-construction details: WEPA 00-1-12011
Figure 9 Water-table construction details: WEPA 00-3-17(WT)12
Figure 10 Piezometer-construction details: WEPA 00-3-79.....13
Figure 11 Piezometer-construction details: WEPA 00-3-158.....14

Acknowledgments

Test hole drilling and piezometer installation were funded jointly by the Government of Alberta, through the Energy and Utilities Board, and by the Government of Canada, through the Ministry of Western Economic Diversification under the Western Economic Partnership Agreement. This Geo-Note is one in a series of Geo-Notes detailing the results of the work completed as part of this project.

The stratigraphic test holes were drilled by the Layne Christiansen Company and by McAuley Drilling Ltd. The piezometer installations were completed by Elk Point Drilling Corp.

Abstract

The Alberta Geological Survey (AGS) completed the installation of nine piezometers in 2000. The piezometers were completed within both Quaternary drift aquifers and a Quaternary-Tertiary buried channel aquifer. Water levels were measured within these piezometers. The results of these measurements indicate that, at all three sites, vertical hydraulic gradients are downwards. At one of the sites (WEPA 00-1), the calculated vertical gradients between three of the nested piezometers are small. This may indicate that the three stratigraphically distinct aquifers monitored by these piezometers may be part of a larger, vertically connected aquifer system, even though they are separated by intervening till packages.

1 Introduction

Between 1999 and 2001, the Alberta Geological Survey conducted a groundwater-sampling program in northeastern Alberta. The purpose was to document baseline groundwater conditions in advance of oil sands development in the area. This project was jointly funded by the Government of Alberta, through the Energy and Utilities Board, and by the Government of Canada, through the Ministry of Western Economic Diversification under the Western Economic Partnership Agreement. This Geo-Note is one in a series of Geo-Notes detailing the results of the work completed as part of this project.

Much of the area of investigation is sparsely populated and, as such, water well and stratigraphic information is difficult to obtain for these areas. To fully understand and characterize the Quaternary and Quaternary-Tertiary hydrogeological systems in northeastern Alberta, several stratigraphic test holes were drilled by the AGS. Detailed stratigraphic and chemical analyses were performed on the collected core material. These analyses are reported in other Geo-Notes of this series. Subsequently, nine piezometers were installed to various depths at three of these sites to characterize water chemistry and capture water-level information from selected aquifers. The purpose of this document is to provide piezometer completion details and document water levels measured in each piezometer at various times between November 2000 and November 2001. Official driller's reports for each piezometer are on file with Alberta Environment.

2 Study Area

The study area is located in the northeastern portion of Alberta. It is bounded on the west by the Athabasca River, to the north by the Athabasca and Clearwater rivers, to the east by the Alberta-Saskatchewan provincial border and to the south by the Mostoos Uplands (Figure 1). This area encompasses the southeast portion of the EUB-designated Athabasca Oil Sands Area.

3 Test Hole Details, Piezometer Completion and Water-Level Information

Latitude, longitude and elevation values were determined using the Locus GPS instrument system by Ashtech Precision Products Limited. One receiver was located over a point of known coordinates, such as an Alberta Survey Control Marker (ASCM), and a second receiver was located at the top of the piezometer's casing. GPS positions are referenced to the WGS84 ellipsoid and modelled against the earth-fixed X, Y, Z Cartesian coordinate system. Ground elevation was established using a steel tape to measure from the top of the casing to ground level.

Water levels were measured using an electric water level tape. For each piezometer, the depth of water from the top of the casing is recorded. The elevation of the water level is determined by subtracting the measured depth to water value, and the height of the casing above ground surface from the top of casing elevation determined during surveying.

3.1 Site WR 99-1

Stratigraphic test hole WR 99-1 was drilled in December 1999 to a depth of 253.7 m. The test hole site is located approximately 45 km north of Wandering River, Alberta (Figure 2). In November 2000, two piezometers were installed at this site, WR 99-1-8(WT) and WR 99-1-230. WR 99-1-8(WT) was completed within the Quaternary drift. WR 99-1-230 was completed within a Quaternary-Tertiary buried channel aquifer of the Wiau Channel. Completion diagrams for the two piezometers are presented in

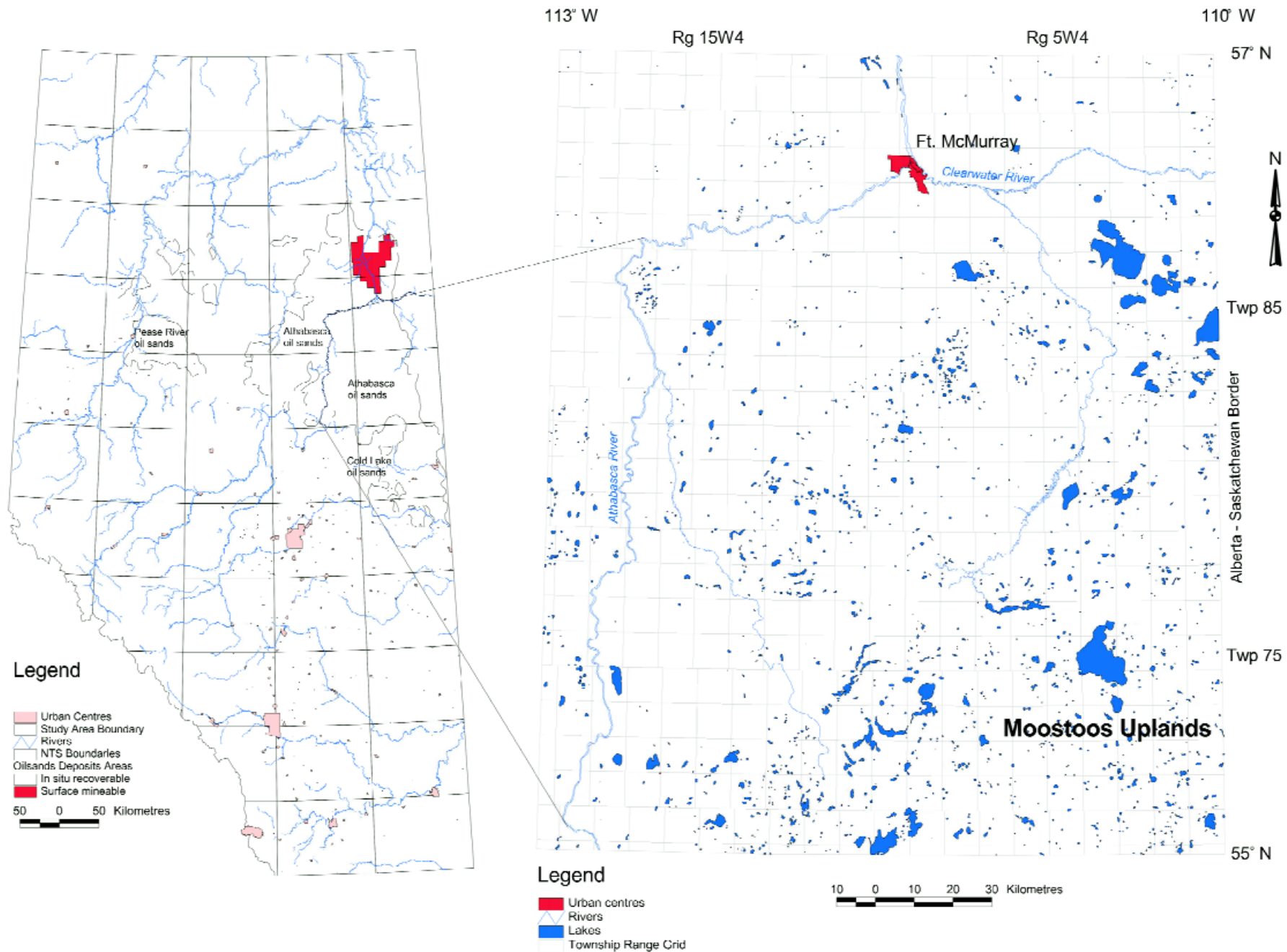
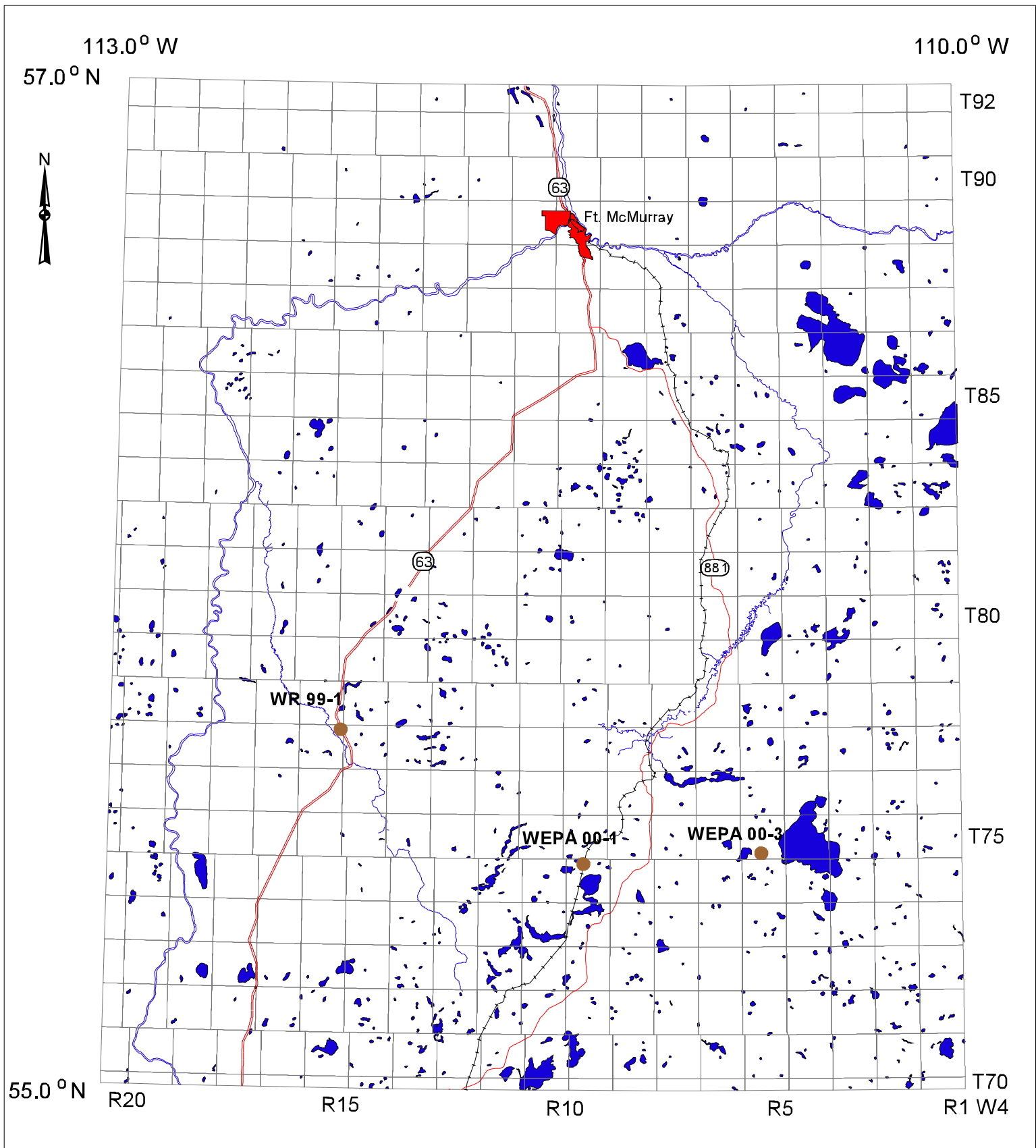


Figure 1. Study area location map.



- Piezometer locations
- Urban centres
- ▤ Railway
- Roads
 - 63
 - 881
- Township Range Grid
- ▬ Rivers
- Lakes

10 0 10 20 Kilometres

Figure 2
Location map of AGS piezometers

Figure 3 and Figure 4. Water level data are presented in Table 1.

3.2 Site WEPA 00-1

Stratigraphic test hole WEPA 00-1 was drilled in October 2000 to a depth of 173.5 m. The test hole site is located approximately 20 km southwest of Conklin, Alberta (Figure 2). In November 2000, four piezometers were completed at this site, all within Quaternary drift aquifers. The piezometers are designated WEPA 00-1-15(WT), WEPA 00-1-41, WEPA 00-1-76 and WEPA 00-120. Completion details are presented in Figure 5, Figure 6, Figure 7 and Figure 8. Water level data are presented in Table 1.

3.3 Site WEPA 00-3

Stratigraphic test hole WEPA 00-3 was drilled in October 2000 to a depth of 182 m. The test hole site is located approximately 30 km east-northeast of Conklin, Alberta (Figure 2). In November 2000, three piezometers were completed at this site, all within Quaternary drift aquifers. The piezometers are designated WEPA 00-3-17(WT), WEPA 00-3-79 and WEPA 00-3-158. Completion details are presented in Figure 9, Figure 10 and Figure 11. Water level data are presented in Table 1.

4 Comment on Vertical Gradients at the Piezometer Sites

At all three piezometer sites, vertical gradients are downwards. Vertical gradients were calculated using the average hydraulic head elevations for each piezometer. Table 2 summarizes these calculated values.

The greatest vertical gradient, 0.30 m/m, is between WR 99-1-8(WT) and WR 99-1-230. The lowest vertical gradient is 0.03 m/m between WEPA 00-1-41 and WEPA 00-1-76. The average calculated vertical gradient is 0.16 m/m and the median value is 0.19 m/m.

At site WEPA 00-1, the vertical gradients between the three deepest piezometers are very similar and approach 0 m/m. This may indicate that the three stratigraphically distinct aquifers monitored by these piezometers may be part of a larger, vertically connected aquifer system, even though they are separated by intervening till packages.

5 Conclusions

Nine piezometers were installed as part of a recent Alberta Geological Survey groundwater characterization project. The piezometers were completed in both Quaternary drift aquifers and a Quaternary-Tertiary buried channel aquifer. Hydraulic head measurements were taken between November 2000 and November 2001. Vertical gradients vary between 0.30 m/m to 0.03 m/m and show that groundwater flow at the various locations is downwards. There are indications that the three deepest aquifers at WEPA 00-1 may be vertically connected, even though they are separated by till packages.

Well Name: WR99-1-8(WT)
 Location (DLS): 07-36-77-15W4
 Latitude: 55.7143976°N
 Longitude: 112.1878725°W
 Datum: NAD83
 Surveyed Ground Level: 663.15 m

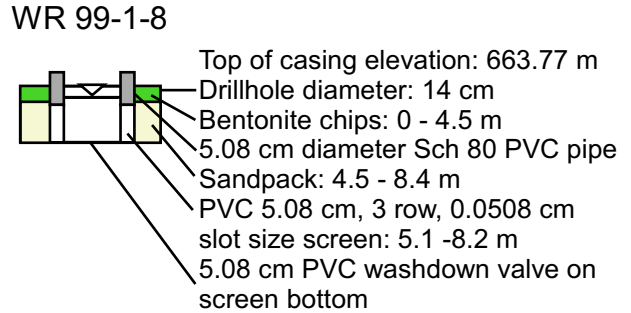
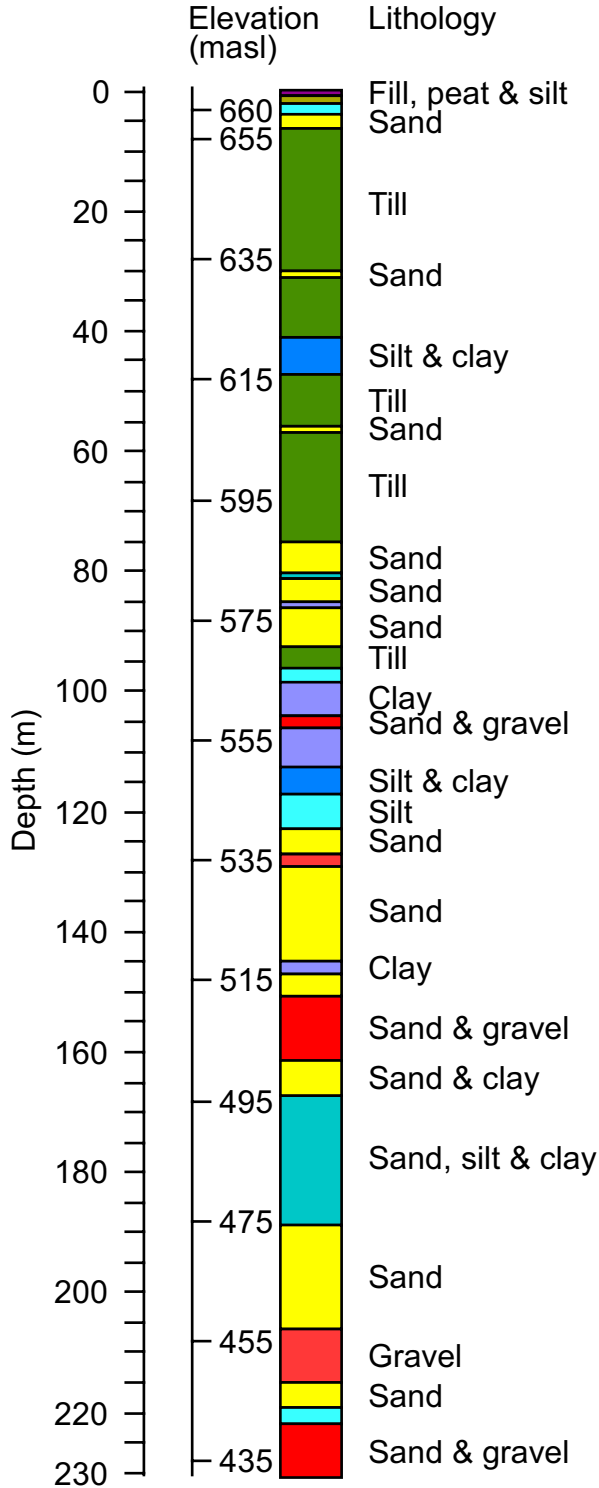


Figure 3. Piezometer-construction details: WR99-1-8(WT).

Well Name: WR99-1-230
 Location (DLS): 07-36-77-15W4
 Latitude: 55.7143794°N
 Longitude: 112.1879148°W
 Datum: NAD83
 Surveyed Ground Level: 663.07 m

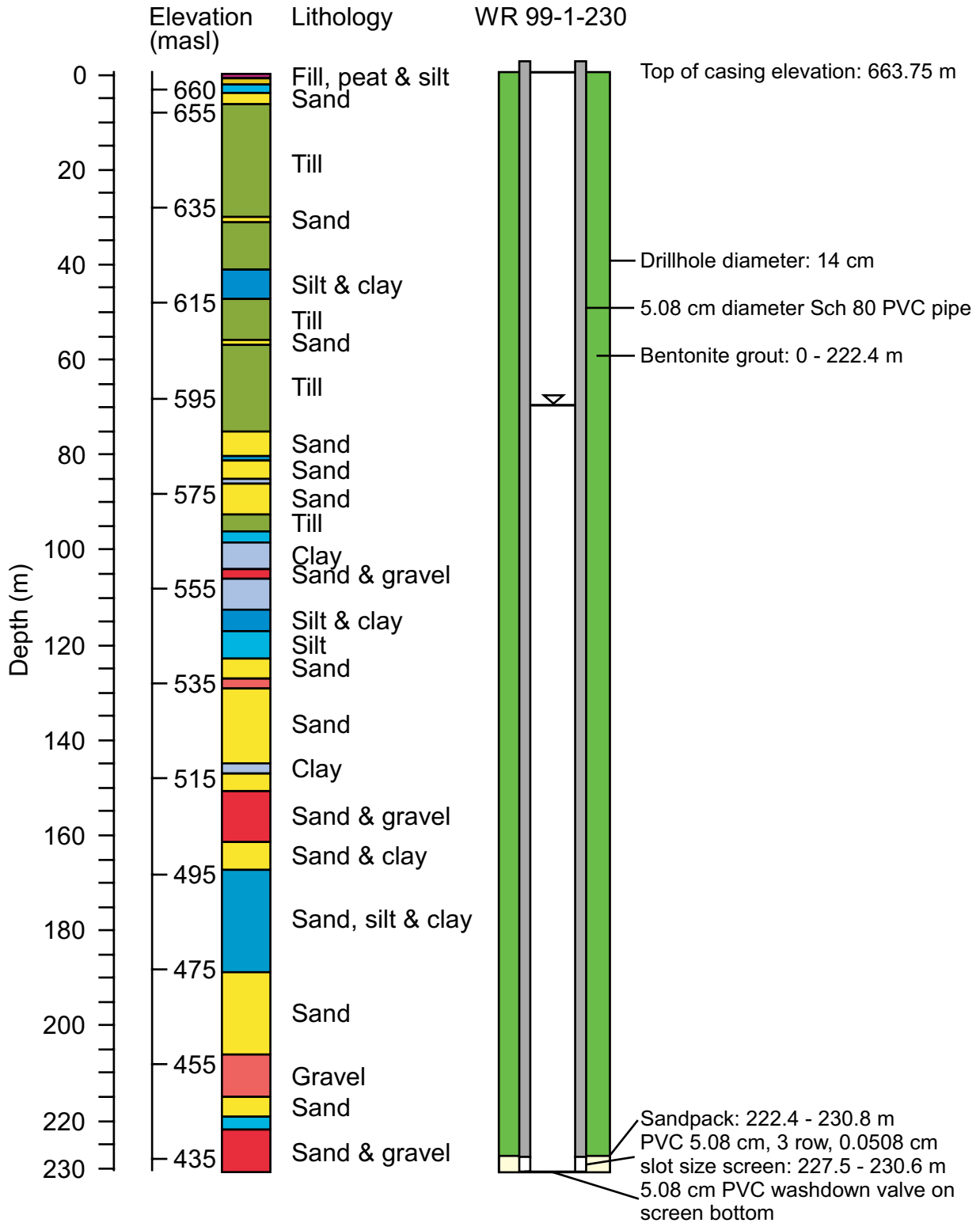


Figure 4. Piezometer-construction details: WR99-1-230.

Table 1. Monthly water level elevations in metres above sea level, November 2000 - November 2001.

Date	WEPA 00-1-15(WT)	WEPA 00-1-41	WEPA 00-1-76	WEPA 00-1-120	WEPA 00-3-17(WT)	WEPA 00-3-79	WEPA 00-3-158	WR 99-1-8(WT)	WR 99-1-230
5-Nov-00	662.934	658.748	657.567	655.738					
9-Nov-00							608.339		
10-Nov-00					636.851	620.4	608.349		
16-Nov-00									593.608
17-Nov-00								661.226	
21-Nov-00	662.944	658.748	657.567	655.748	637.031	624.55	608.399	661.526	593.648
6-Dec-00	662.894	658.748	657.577	655.788	637.061	624.55	608.409		
7-Dec-00								661.406	593.608
5-Feb-01	662.664	658.608	657.467	655.698	636.991	624.55	608.389		
7-Feb-01								661.286	593.588
19-Mar-01	662.504	658.543	657.407	655.658	636.951	624.59	608.419	661.246	593.628
24-Apr-01	662.424	658.468	657.337	655.588	636.916	624.56	608.359		
25-Apr-01								661.476*	593.608
7-May-01	662.434	658.478	657.347	655.588					
10-May-01					636.901	624.56	608.369		
22-May-01	662.454	658.498	657.367	655.608					
23-May-01					636.911	624.5	608.379	661.626*	593.618
21-Jun-01	662.614	658.608	657.437	655.638	637.011	624.52	608.389	661.706	593.628
25-Jul-01	663.354	658.718	657.517	655.698	637.181	624.53	608.449	661.536	593.598
27-Aug-01	663.114	658.698	657.517	655.688	637.391	624.5	608.419	661.436	593.578
25-Sep-01	662.914	658.668	657.497	655.688	637.581	624.52	608.389	661.416	593.578
25-Oct-01	662.784	658.638	657.467	655.648	637.511	624.5	608.319	661.466	593.538
26-Nov-01	662.684	658.618	657.457	655.658	637.561	624.5	608.299	661.366	593.508

Well Name: WEPA 00-1-15(WT)
 Location (DLS): 06-33-074-09W4M
 Latitude: 55.4514162°N
 Longitude: 111.3298313°W
 Datum: NAD 83
 Surveyed Ground Level: 666.83 m

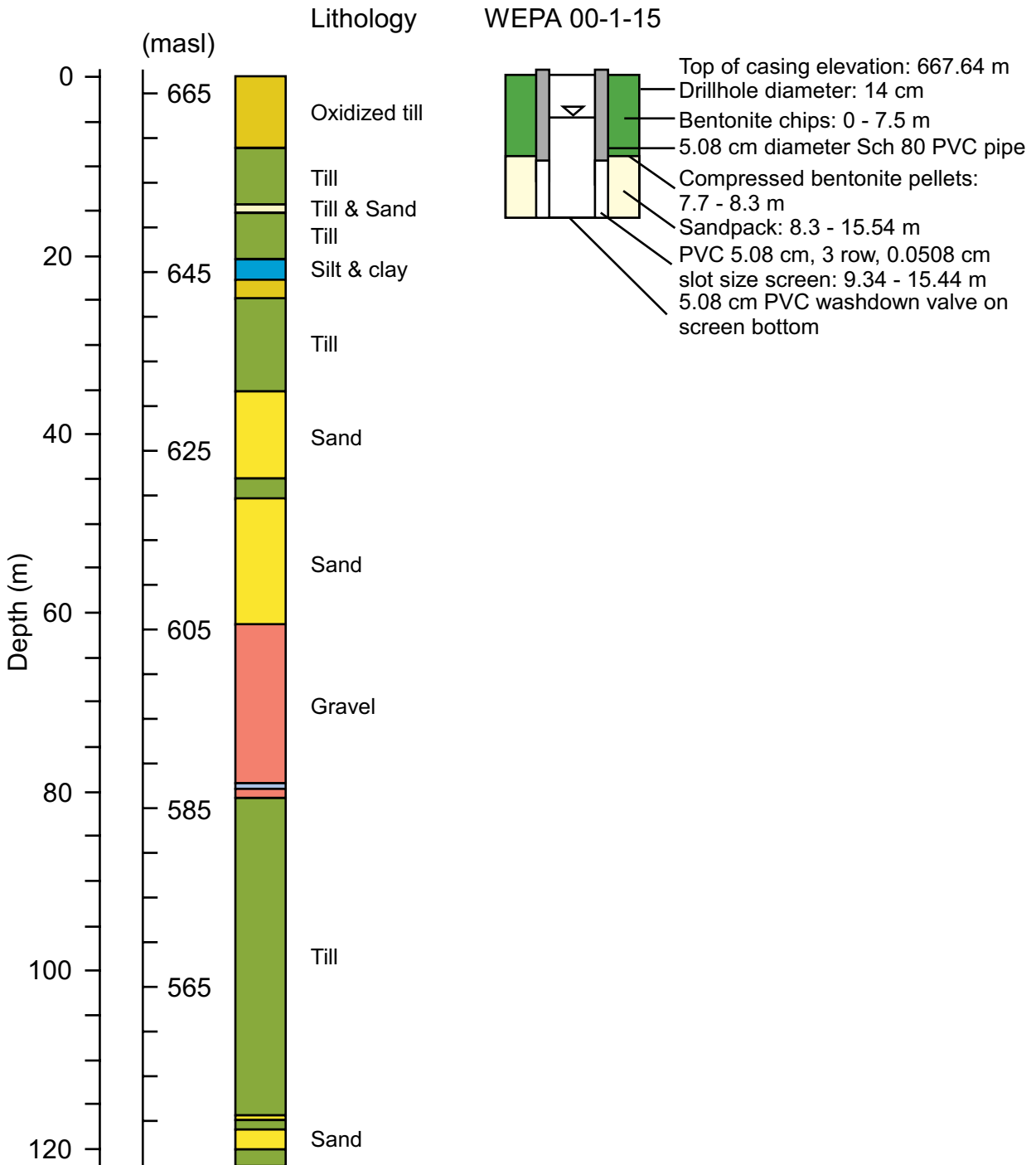


Figure 5. Piezometer construction details: WEPA 00-1-15(WT).

Well Name: WEPA 00-1-41
 Location (DLS): 06-33-074-09W4M
 Latitude: 55.4513766°N
 Longitude: 111.3298244°W
 Datum: NAD 83
 Surveyed Ground Level: 667.01 m

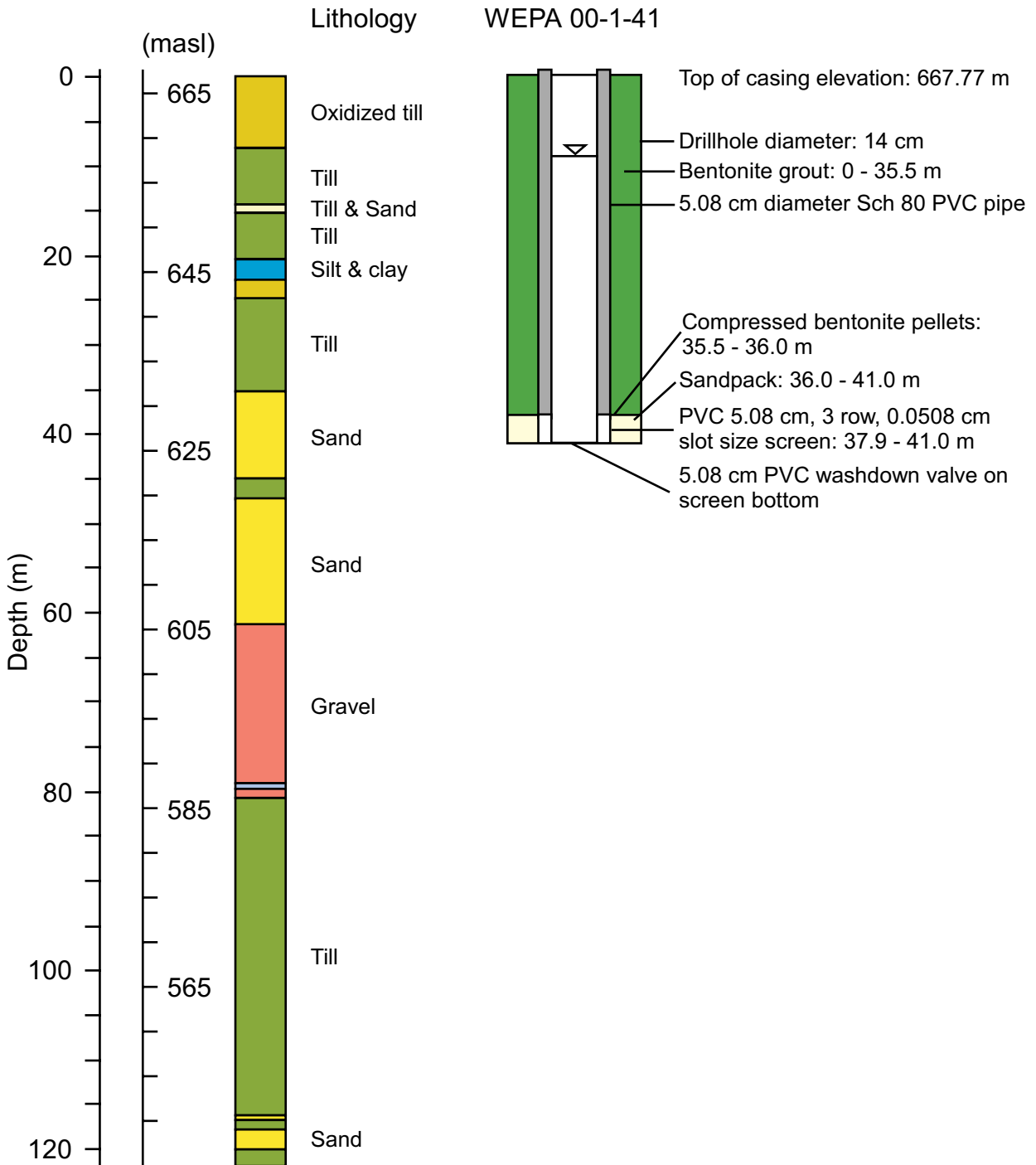


Figure 6. Piezometer construction details: WEPA 00-1-41.

Well Name: WEPA 00-1-76
 Location (DLS): 06-33-074-09W4M
 Latitude: 55.4513830°N
 Longitude: 111.3299586°W
 Datum: NAD 83
 Surveyed Ground Level: 666.99 m

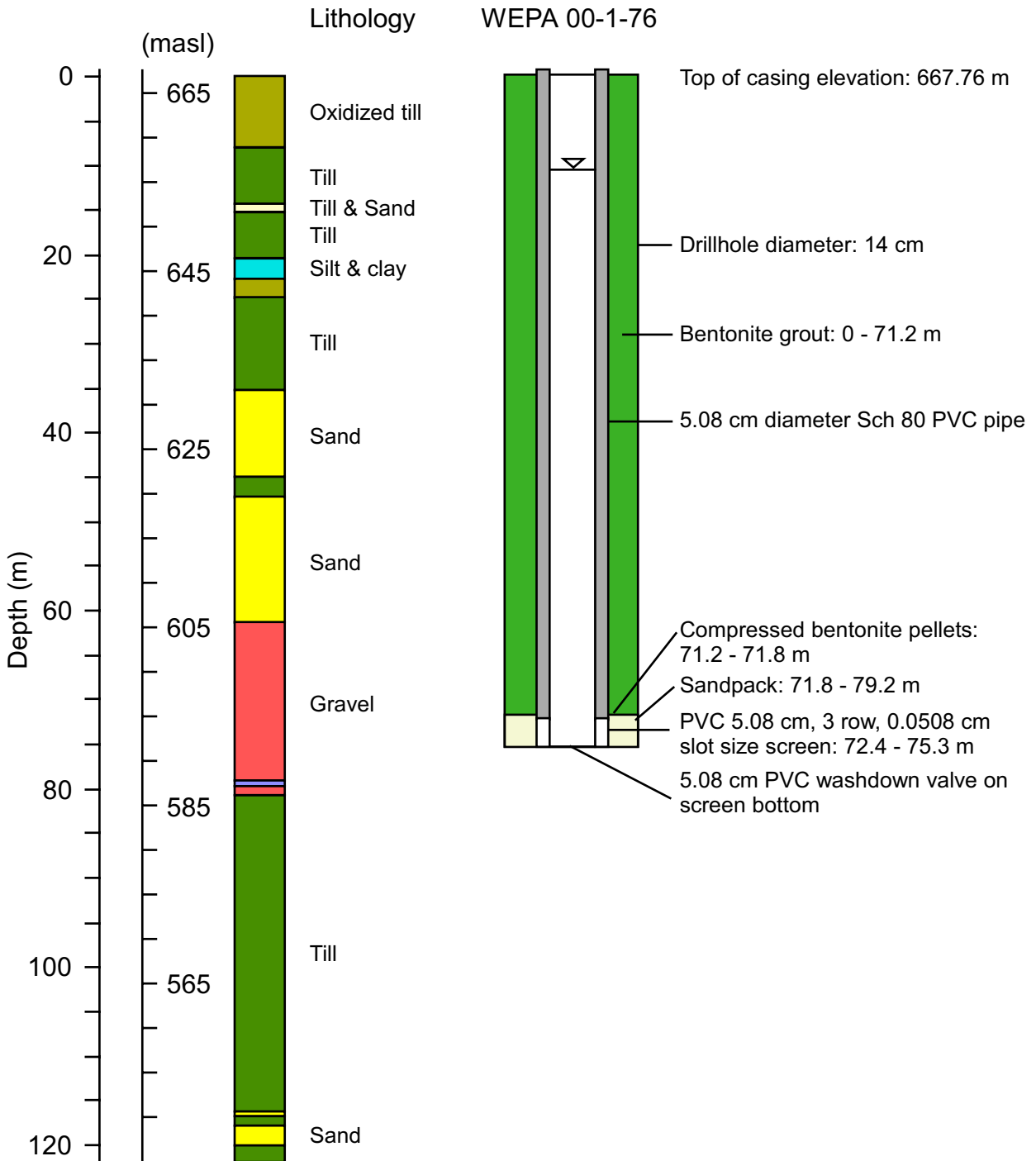


Figure 7. Piezometer construction details: WEPA 00-1-76.

Well Name: WEPA 00-1-120
 Location (DLS): 06-33-074-09W4M
 Latitude: 55.4513762°N
 Longitude: 111.3298897°W
 Datum: NAD 83
 Surveyed Ground Level: 666.92 m

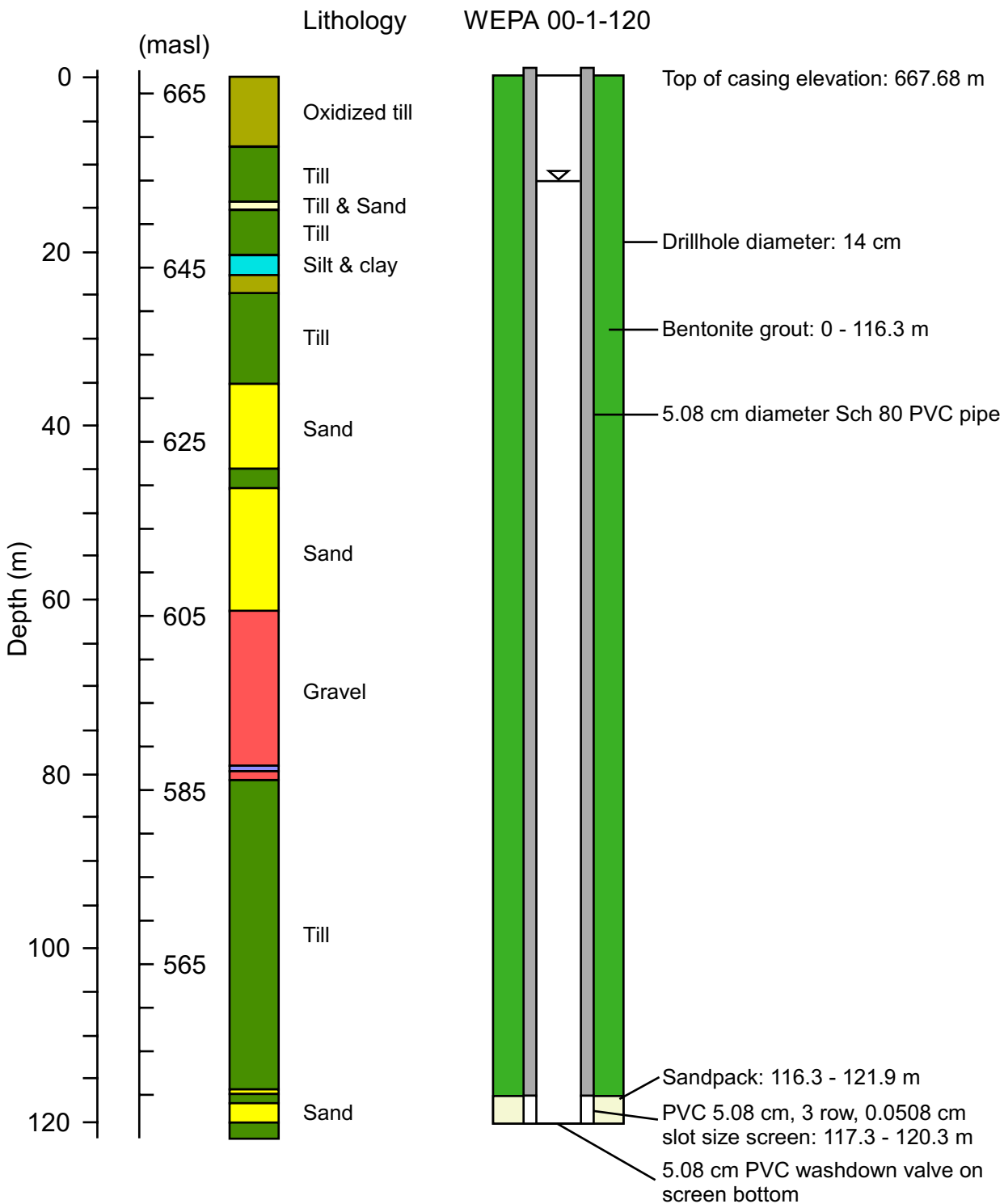


Figure 8. Piezometer construction details: WEPA 00-1-120.

Well Name: WEPA 00-3-17(WT)
 Location (DLS): 16-04-075-05W4M
 Latitude: 55.4730401°N
 Longitude: 110.7072983°W
 Datum: NAD83
 Surveyed Ground Level: 648.17 m

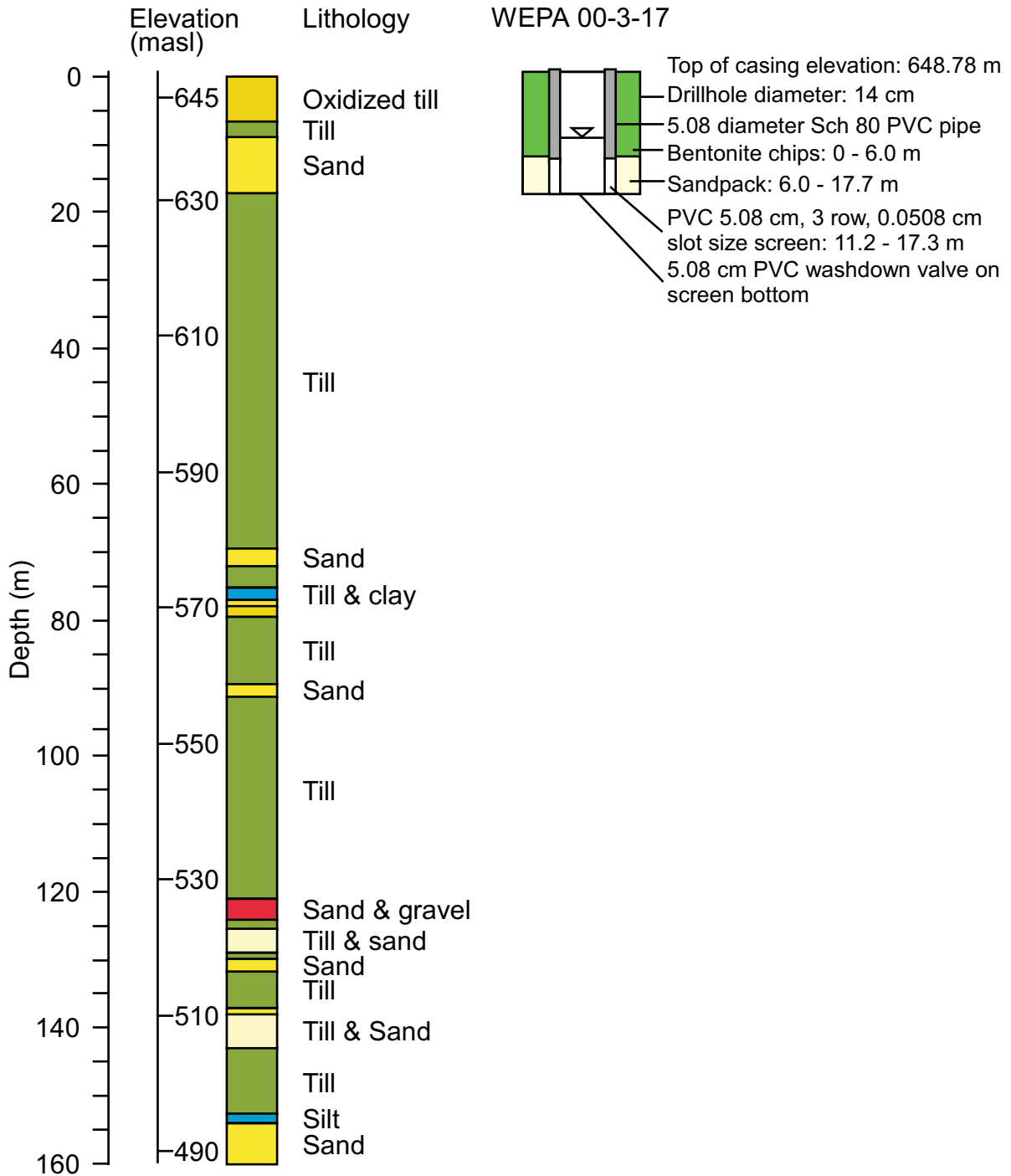


Figure 9. Piezometer-construction details: WEPA 00-3-17(WT).

Well Name: WEPA 00-3-79
 Location (DLS): 16-04-075-05W4M
 Latitude: 55.4730068°N
 Longitude: 110.7073184°W
 Datum: NAD83
 Surveyed Ground Level: 648.26 m

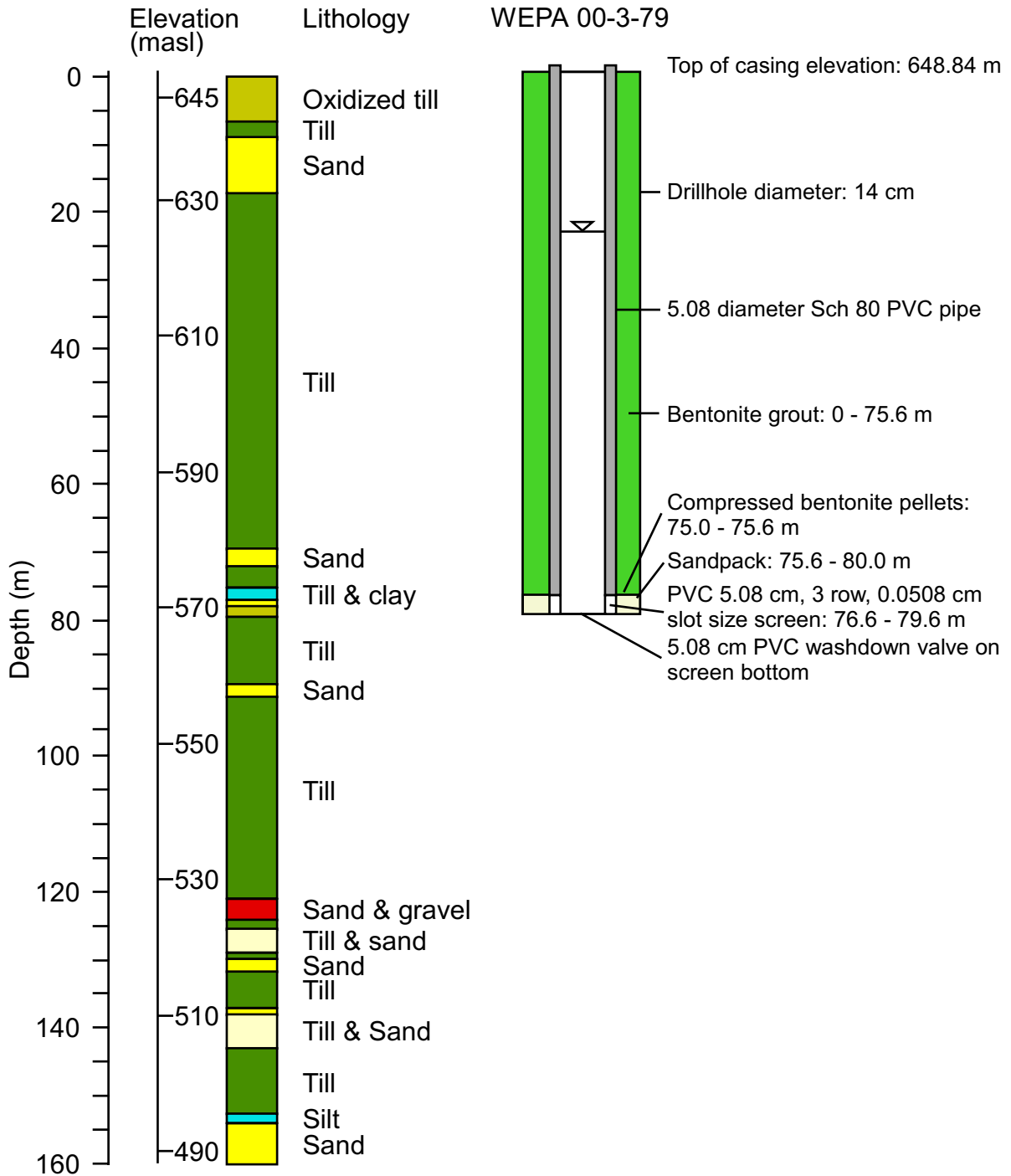


Figure 10. Piezometer-construction details: WEPA 00-3-79.

Well Name: WEPA 00-3-158
 Location (DLS): 16-04-075-05W4M
 Latitude: 55.4729752°N
 Longitude: 110.7073340°W
 Datum: NAD83
 Surveyed Ground Level: 648.20 m

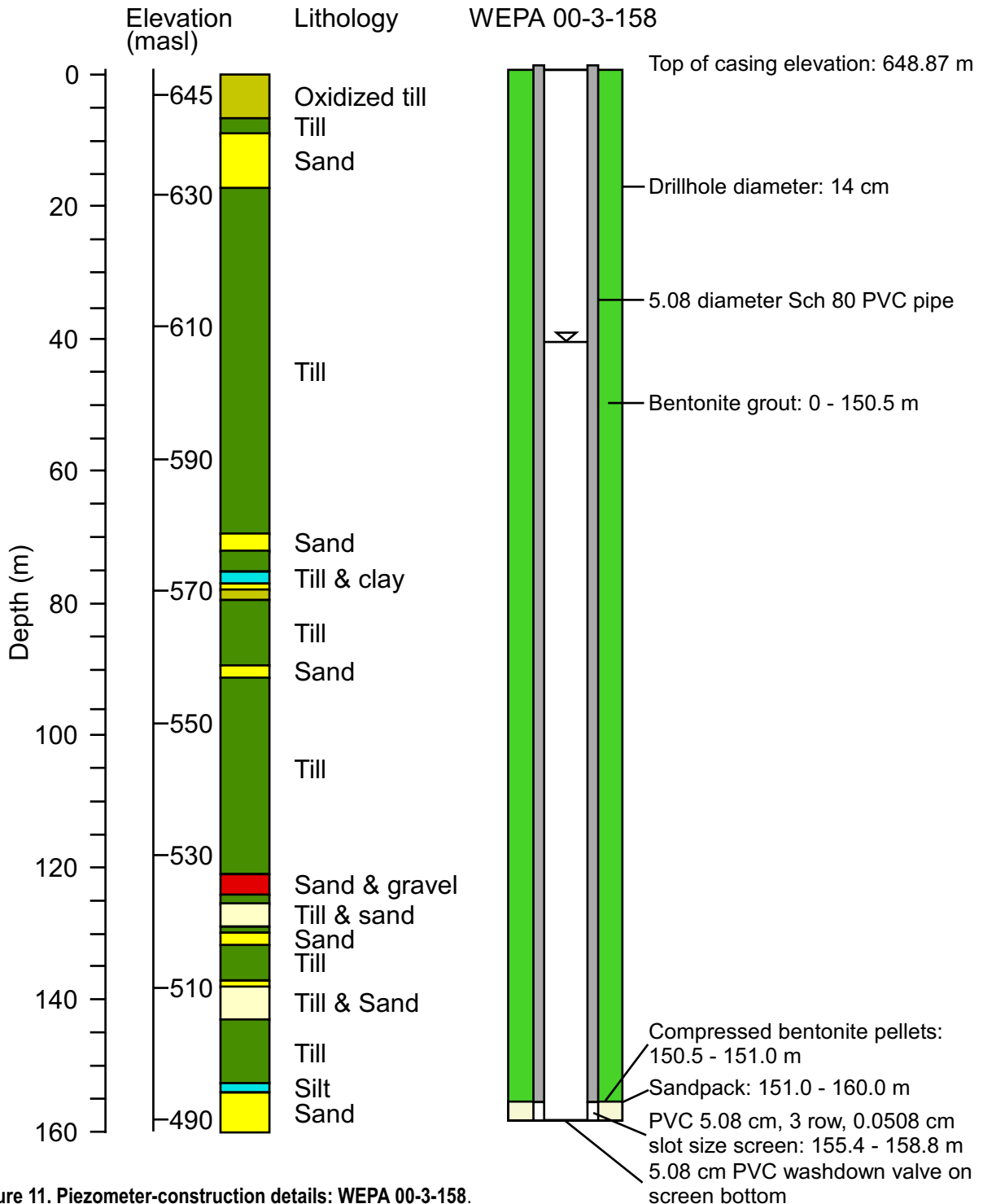


Figure 11. Piezometer-construction details: WEPA 00-3-158.

Table 2. Calculated vertical gradients.

Calculated Vertical Gradient (m/m)	Interval	
	Top Piezometer	Bottom Piezometer
0.30	WR 99-1-8	WR 99-1-230
0.20	WEPA 00-1-15	WEPA 00-1-14
0.03	WEPA 00-1-41	WEPA 00-1-76
0.04	WEPA 00-1-76	WEPA 00-1-120
0.22	WEPA 00-3-17	WEPA 00-1-79
0.19	WEPA 00-3-79	WEPA 00-3-158