Appendix 3. Final Grand Ditch Report (2009-2010 task agreement). Rocky Mountain National Park, CO. Covey Potter and Dr. David Cooper.

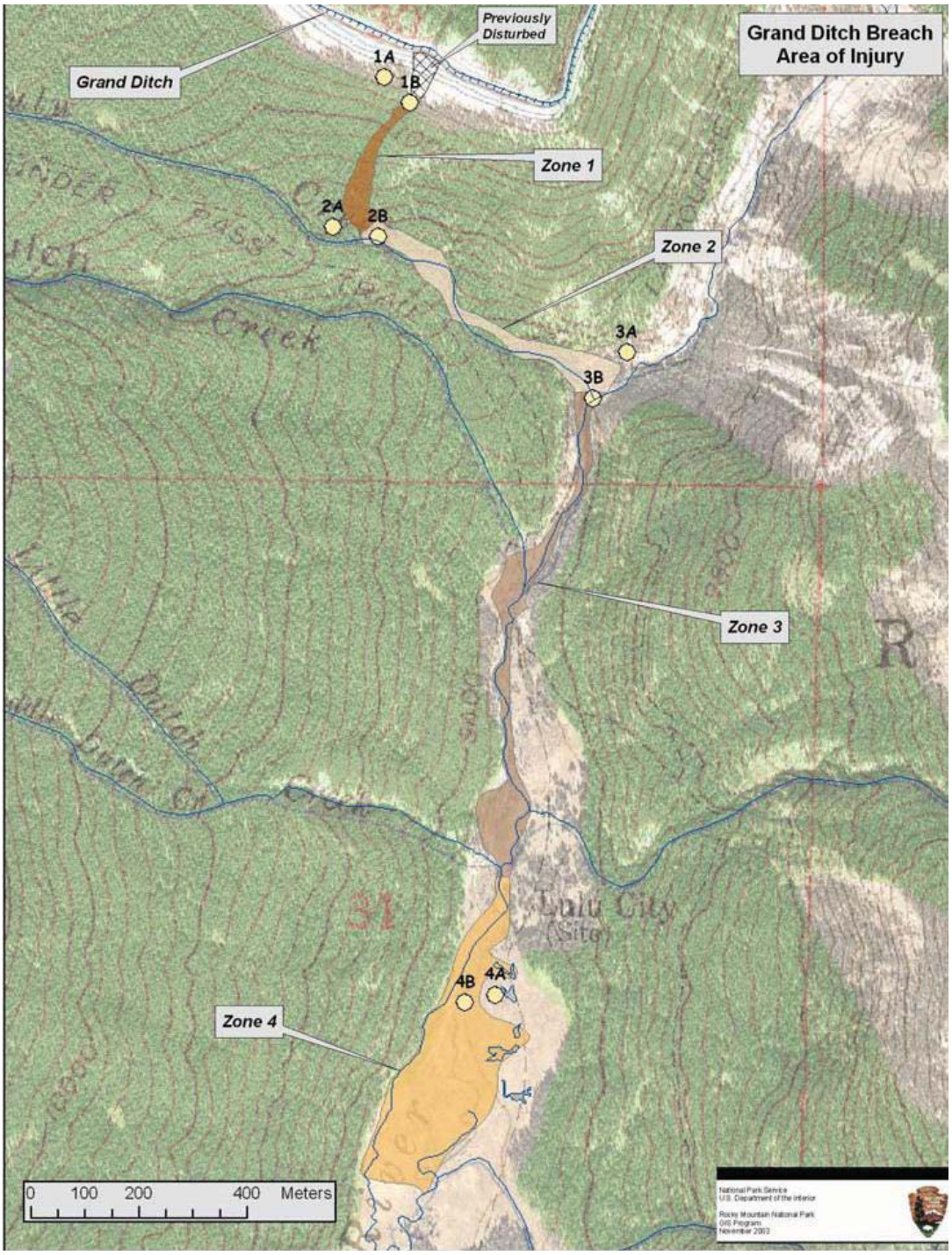


Figure 1: Areas of injury from the 2003 Grand Ditch Breach. Figure shows zones of impact. From Cooper Expert Report 2008.

Figure 2: Photo of Shipler Park onsite reference site. Demonstrating groundwater well and staff gage placement for water table monitoring.

Reference Site	Well	X	Y	Notes
Shilpler Park	540	427738	4475405	Well
	541	427745	4475417	Well
	542	427722	4475417	Well
	543	427718	4475416	Well
	544	427735	4475421	Well
	545r	427733	4475399	Rebar Gage
	546	427717	4475408	Well
	547	427716	4475402	Well
	548	427716	4475393	Well
Lost Creek	520	427753	4474494	Well
	521	427746	4474508	Well
	522r	427748	4474483	Rebar Gage
	523	427751	4474558	Well
	524	427745	4474568	Well
	525	427741	4474573	Well
	526	427738	4474586	Well
	527	427760	4474624	Well
	528	427766	4474620	Well
	529	427778	4474626	Well
	530r	427772	4474626	Rebar Gage
	531	427737	4474570	Well
	532	427772	4474641	Well
	533	427728	4474547	Well
	534	427731	4474568	Well
	535	427736	4474561	Well
Sawmill Creek	560	427936	4478462	Well
	561	427930	4478467	Well
	562	427925	4478436	Well
	563	427936	4478452	Well
	564	427949	4478436	Well
	565	427936	4478421	Well
Beaver Creek Confluence	511	427862	4471777	Well
	512	427880	4471754	Well
	513	427864	4471743	Well
	514	427897	4471722	Well
	515	427930	4471666	Well
	516	427799	4471749	Well
	517	427788	4471752	Well

Table 1: Reference site groundwater monitoring well and gage locations. Rocky Mountain National Park, CO

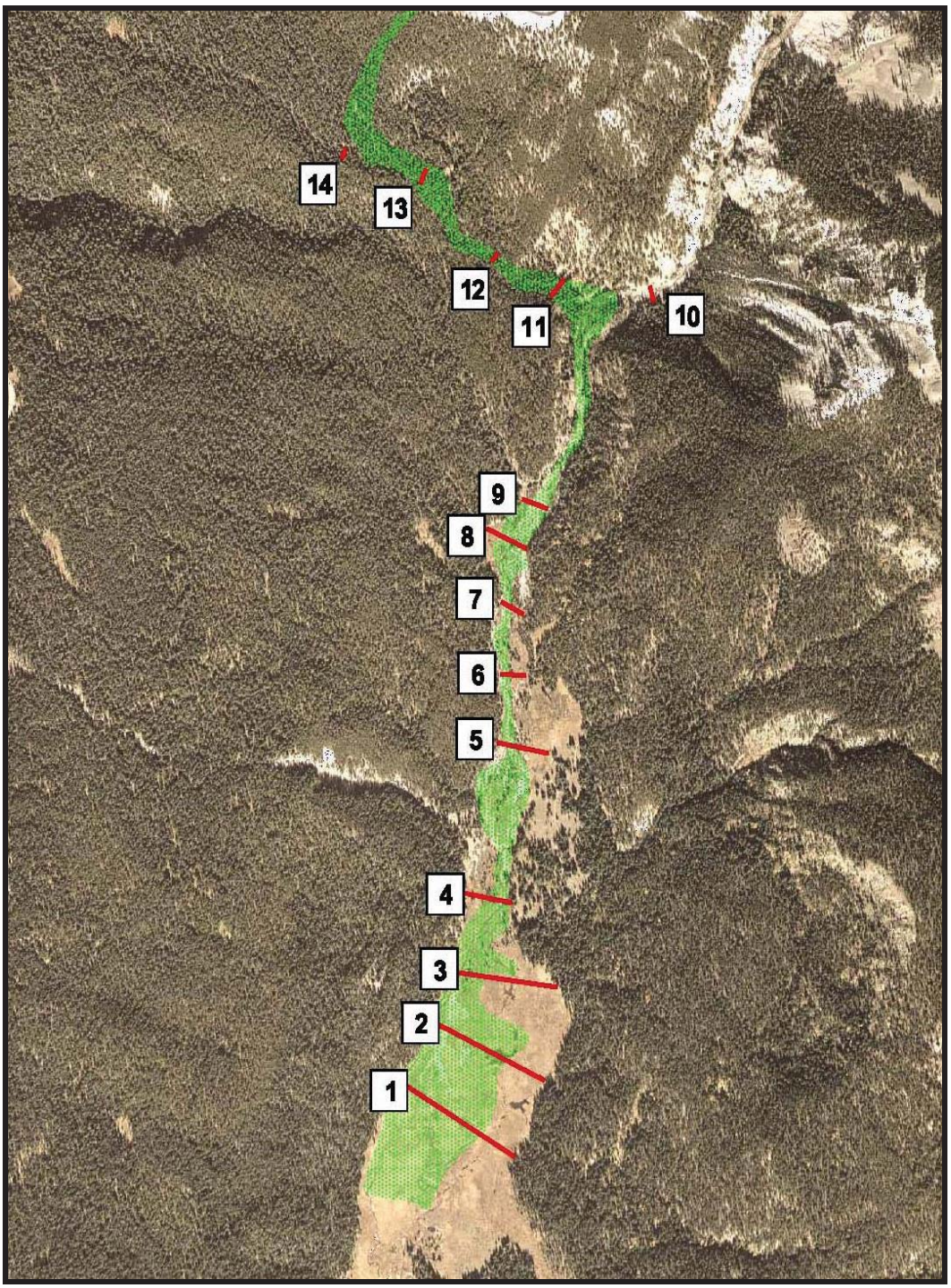


Figure 3. Groundwater monitoring well transects along the affected reaches of Lulu Creek and the Colorado River. Rocky Mountain National Park, CO. Installed 2003 and 2004 (Gage 2005).

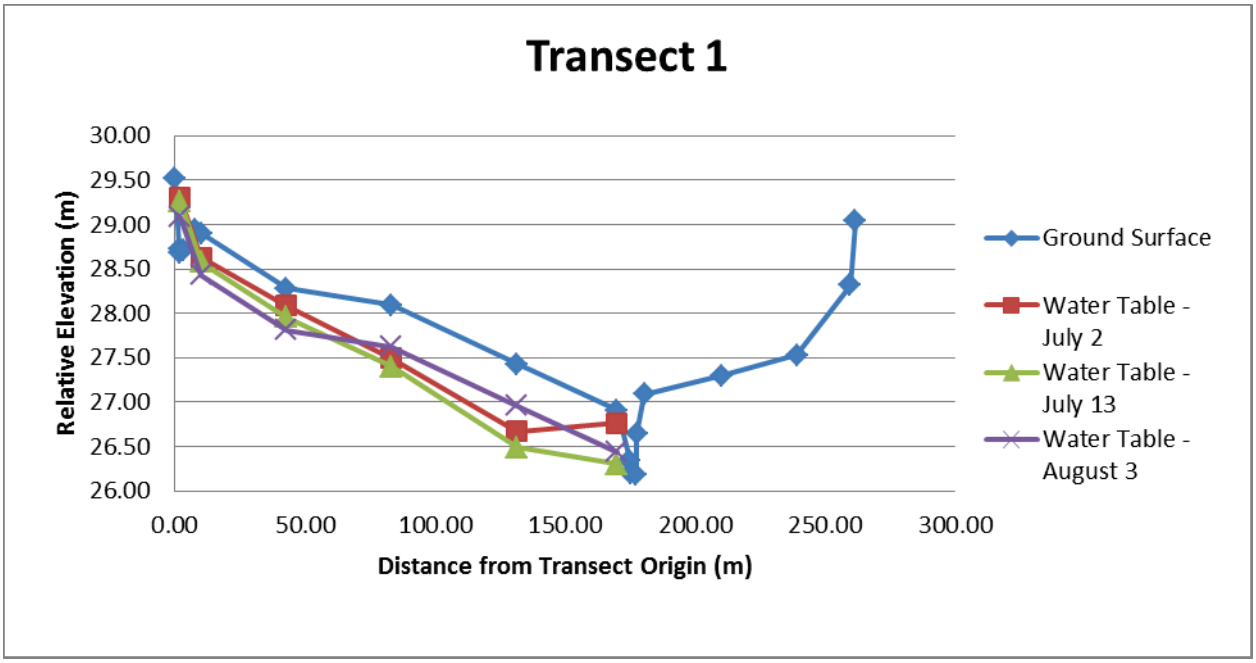


Figure 4. 2-dimensional cross section of transect 1 shown in Figure 1. This cross section describes a somewhat stable ground surface combined with monthly variations in 2009 depth to groundwater collected from the groundwater monitoring wells.

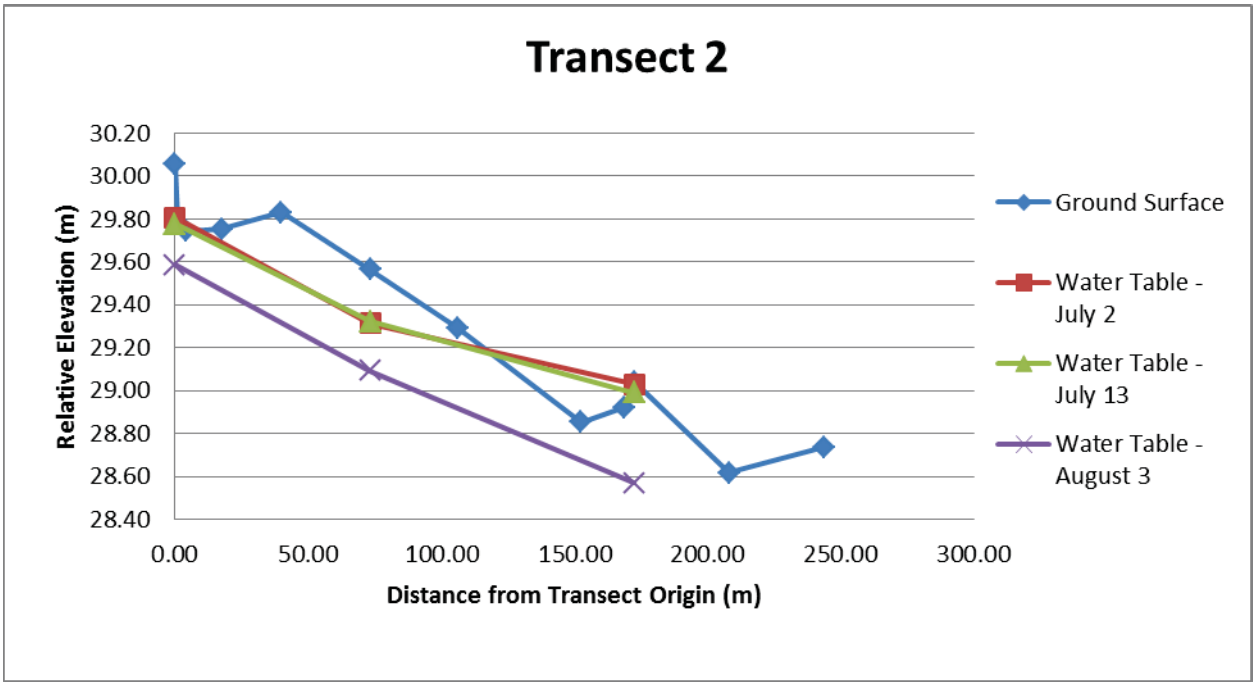


Figure 5. 2-dimensional cross section of transect 2 shown in Figure 1. This cross section describes a somewhat stable ground surface combined with monthly variations in 2009 depth to groundwater collected from the groundwater monitoring wells.

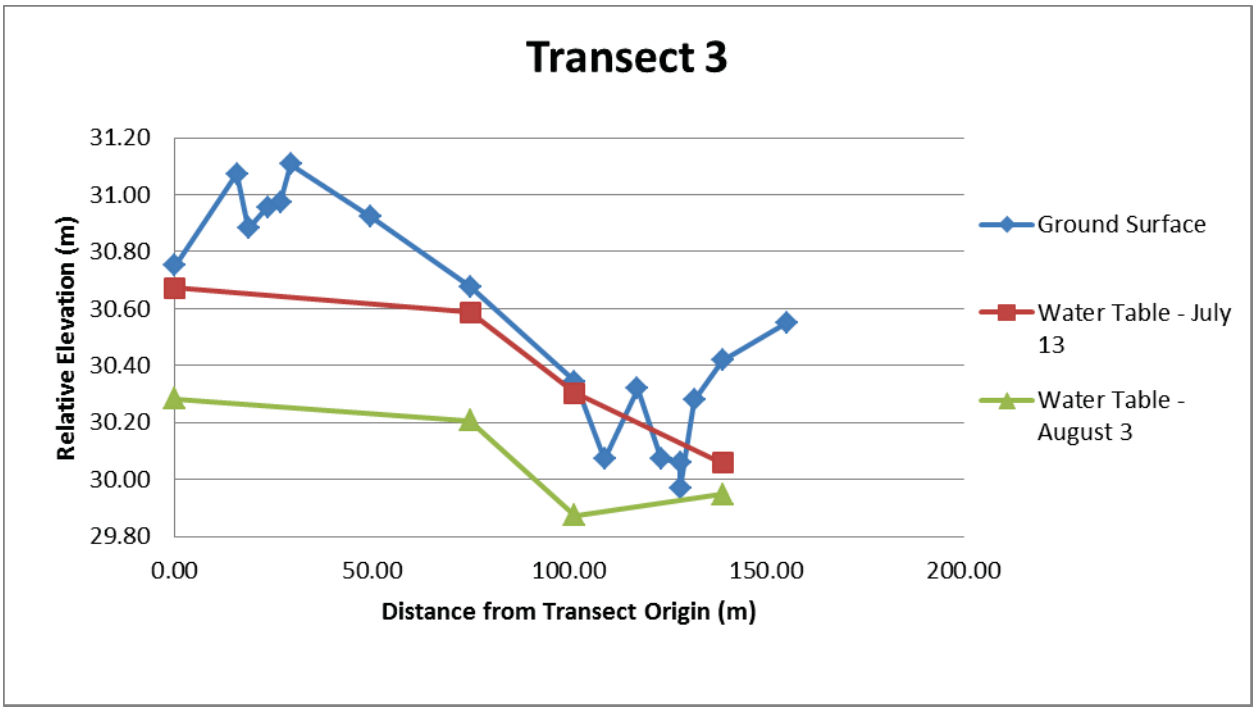


Figure 6. 2-dimensional cross section of transect 3 shown in Figure 1. This cross section describes a somewhat stable ground surface combined with monthly variations in 2009 depth to groundwater collected from the groundwater monitoring wells.

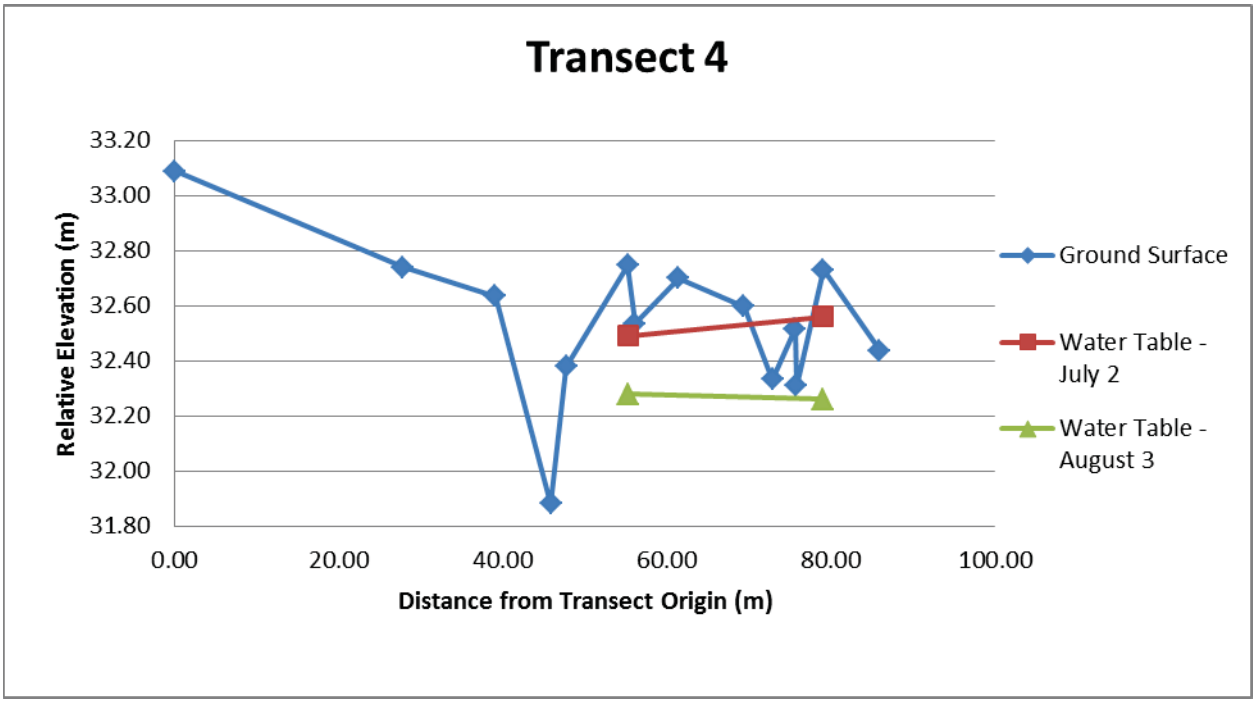


Figure 7. 2-dimensional cross section of transect 4 shown in Figure 1. This cross section describes a somewhat stable ground surface combined with monthly variations in 2009 depth to groundwater collected from the groundwater monitoring wells.

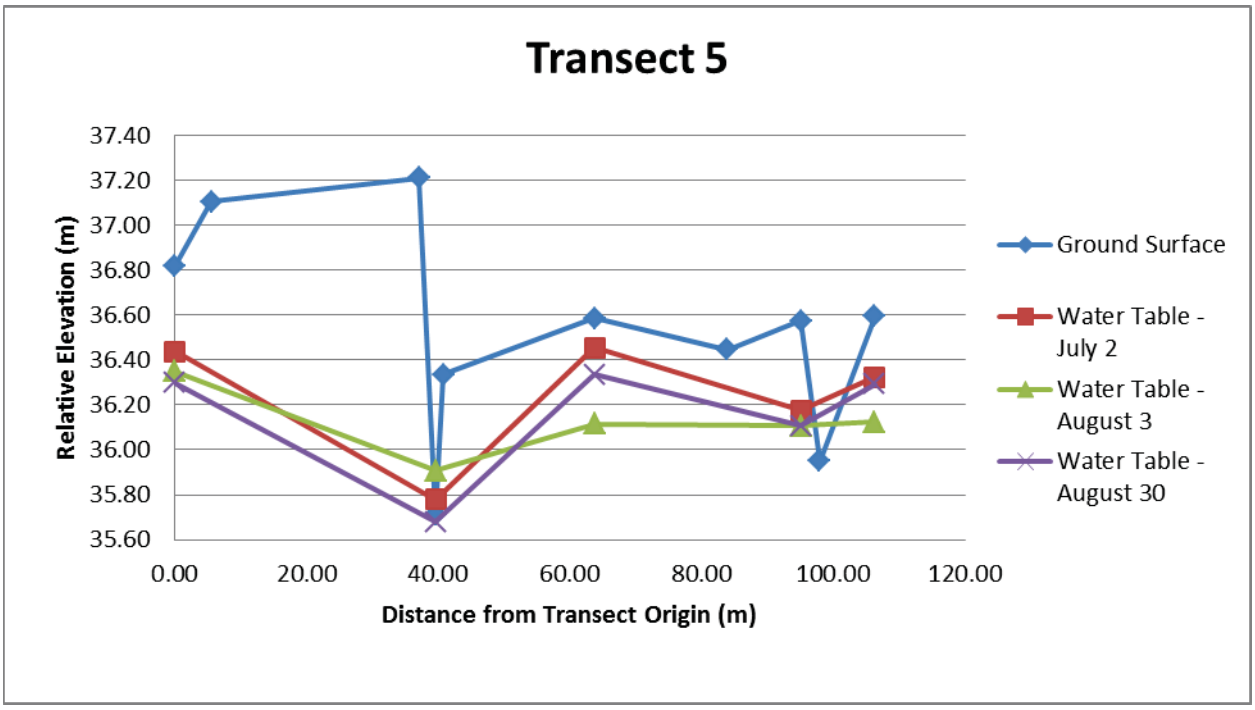


Figure 8. 2-dimensional cross section of transect 5 shown in Figure 1. This cross section describes a somewhat stable ground surface combined with monthly variations in 2009 depth to groundwater collected from the groundwater monitoring wells.

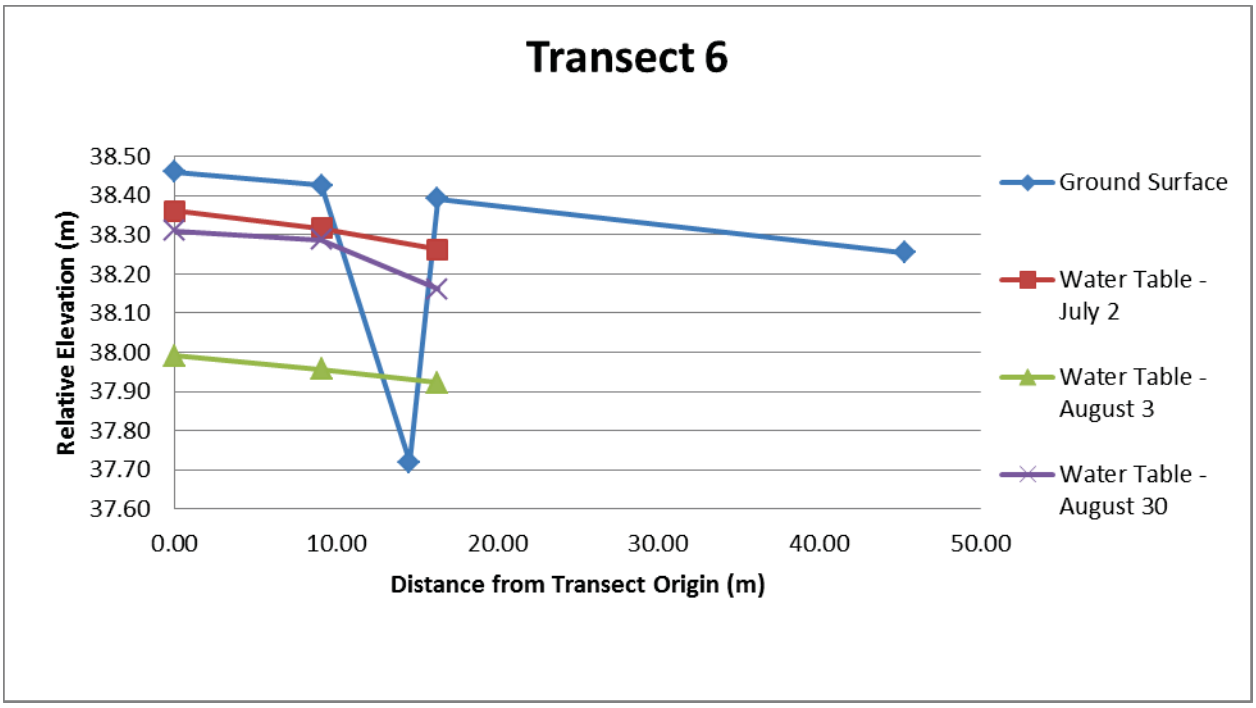


Figure 9. 2-dimensional cross section of transect 6 shown in Figure 1. This cross section describes a somewhat stable ground surface combined with monthly variations in 2009 depth to groundwater collected from the groundwater monitoring wells.

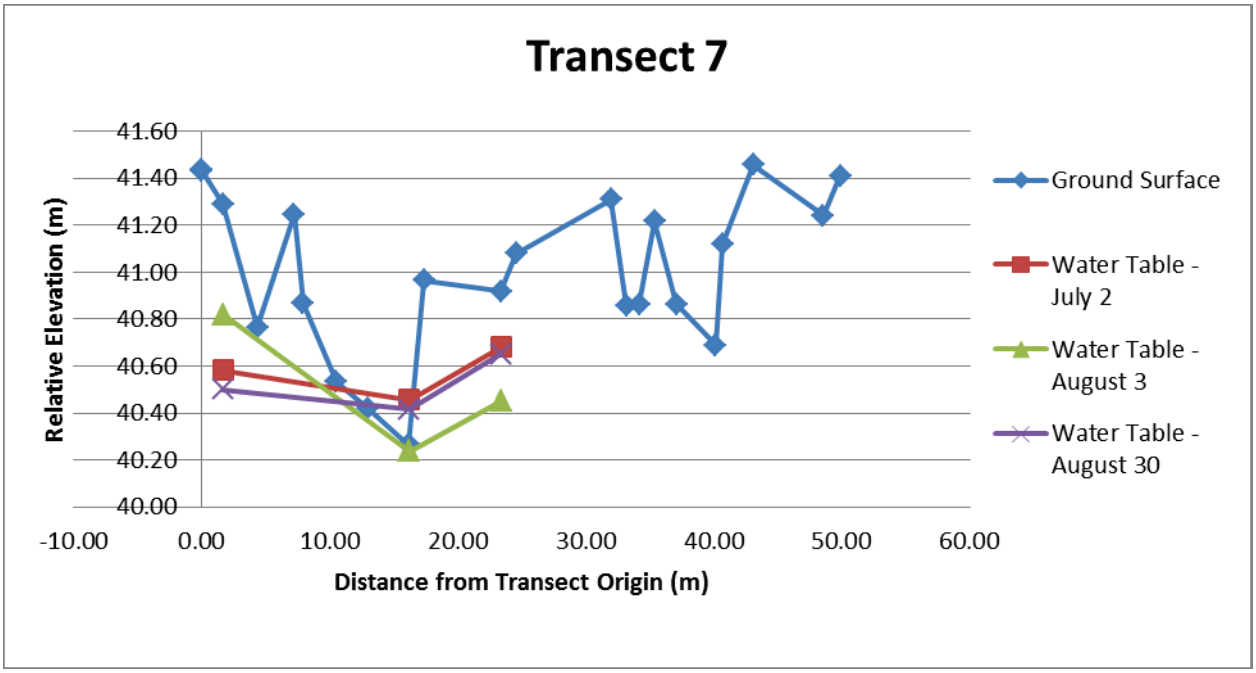


Figure 10. 2-dimensional cross section of transect 7 shown in Figure 1. This cross section describes a somewhat stable ground surface combined with monthly variations in 2009 depth to groundwater collected from the groundwater monitoring wells.

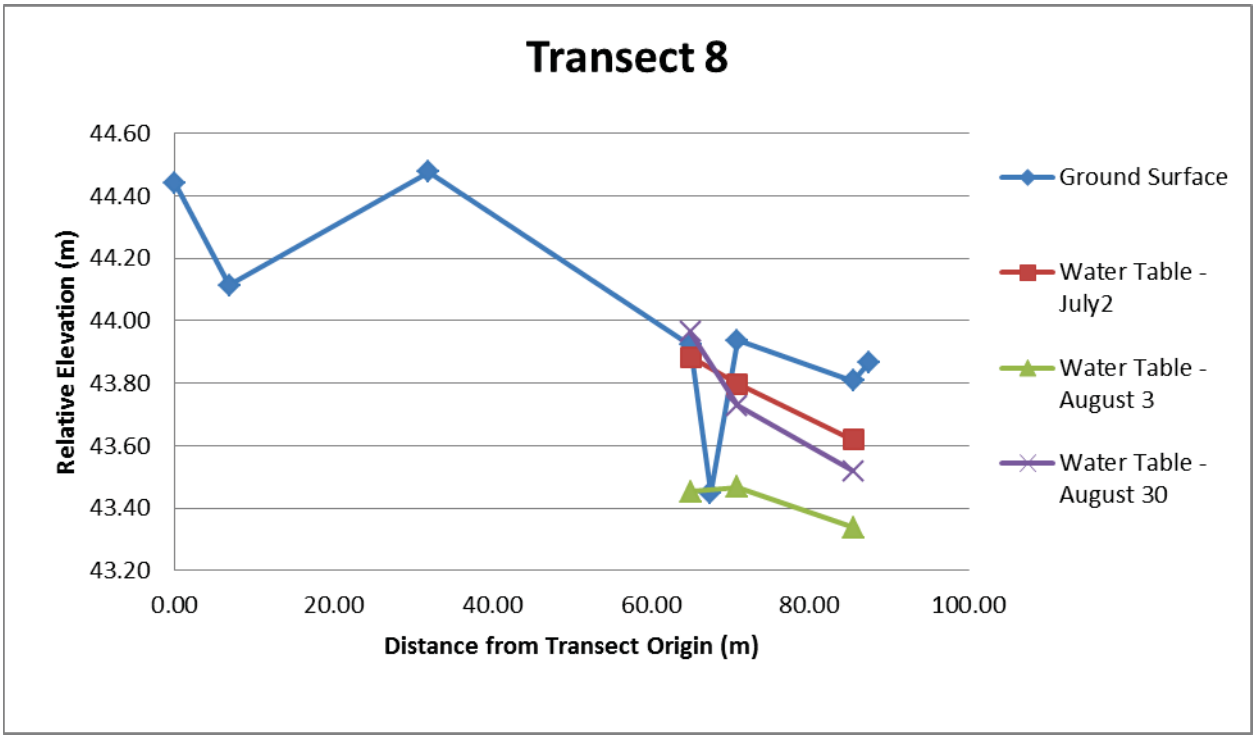


Figure 11. 2-dimensional cross section of transect 8 shown in Figure 1. This cross section describes a somewhat stable ground surface combined with monthly variations in 2009 depth to groundwater collected from the groundwater monitoring wells.

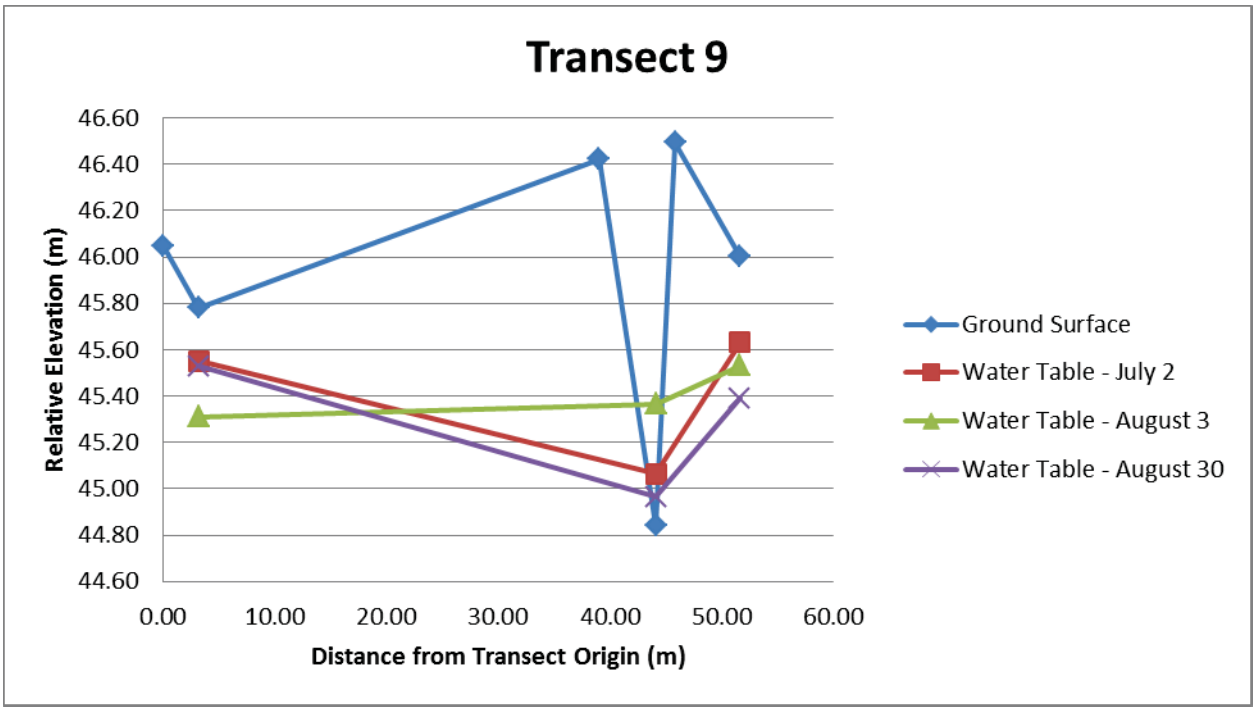


Figure 12. 2-dimensional cross section of transect 9 shown in Figure 1. This cross section describes a somewhat stable ground surface combined with monthly variations in 2009 depth to groundwater collected from the groundwater monitoring wells.

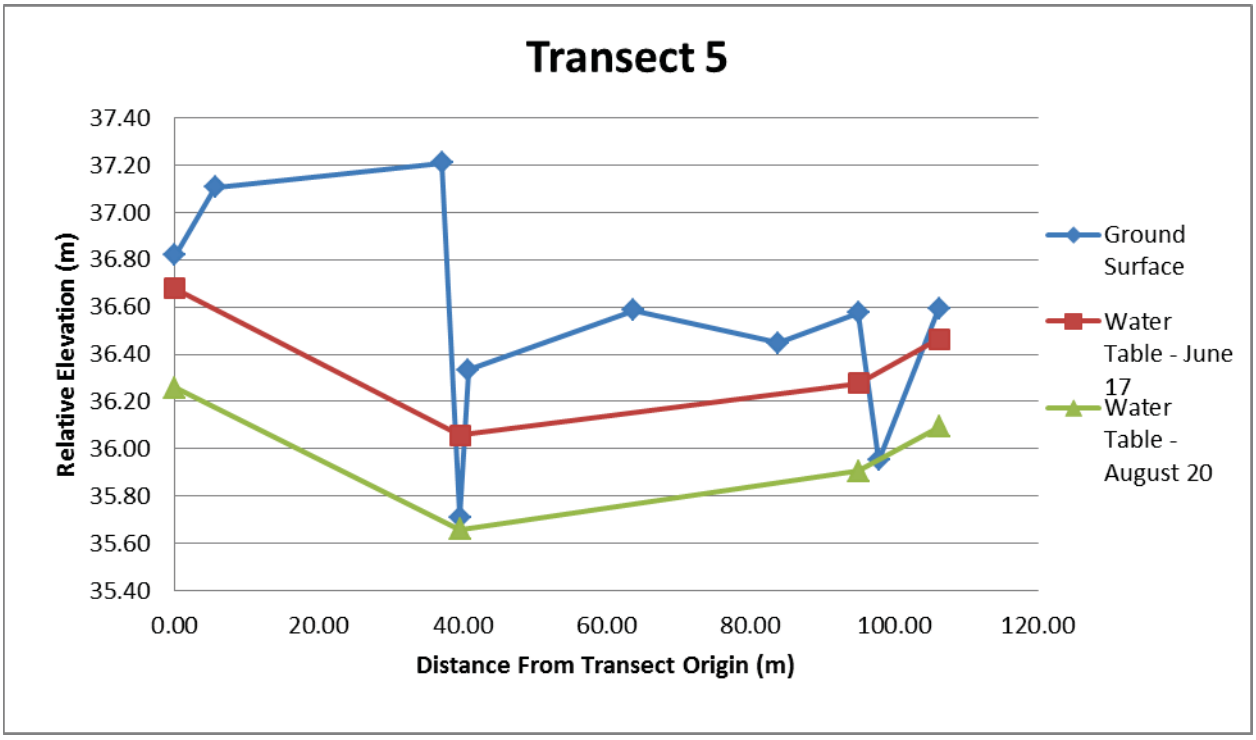


Figure 13. 2-dimensional cross section of transect 5 shown in Figure 1. This cross section describes a somewhat stable ground surface combined with monthly variations in 2010 depth to groundwater collected from the groundwater monitoring wells.

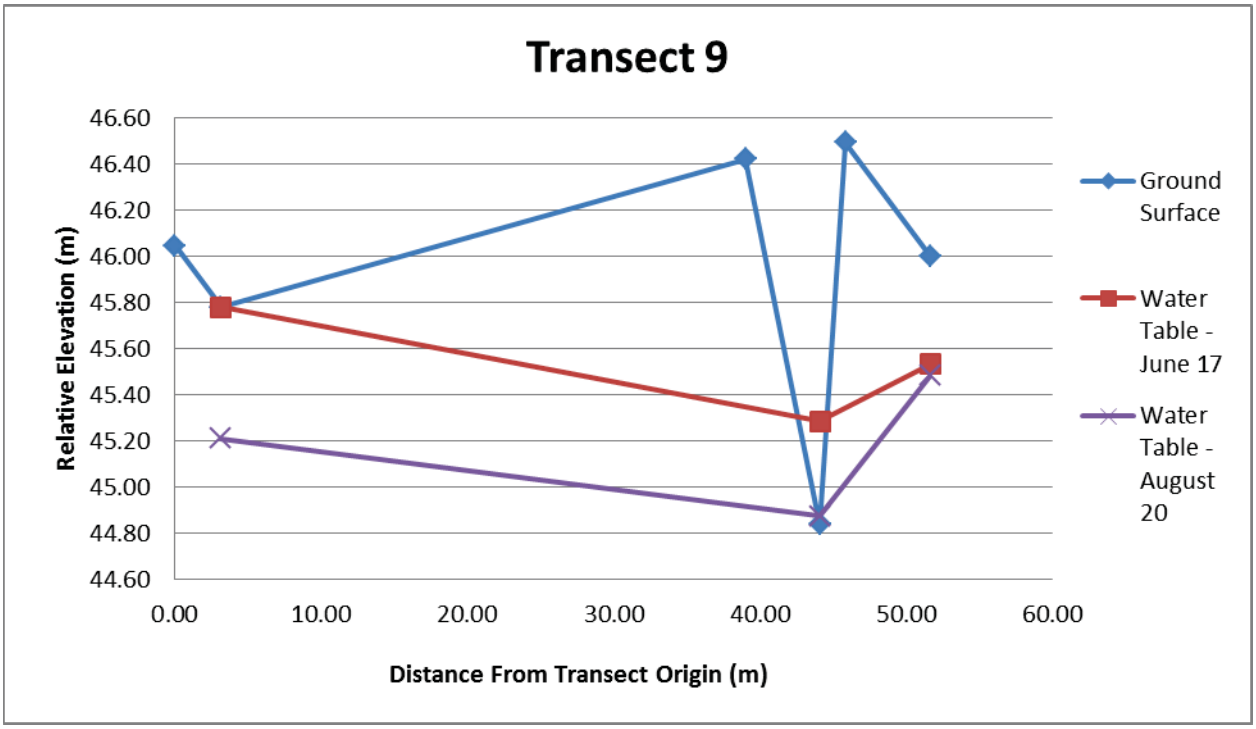
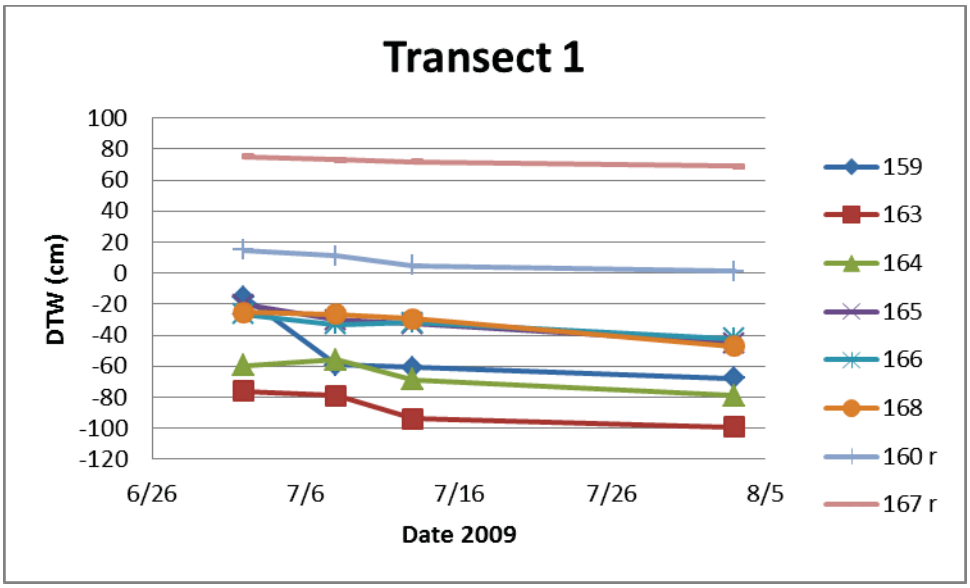
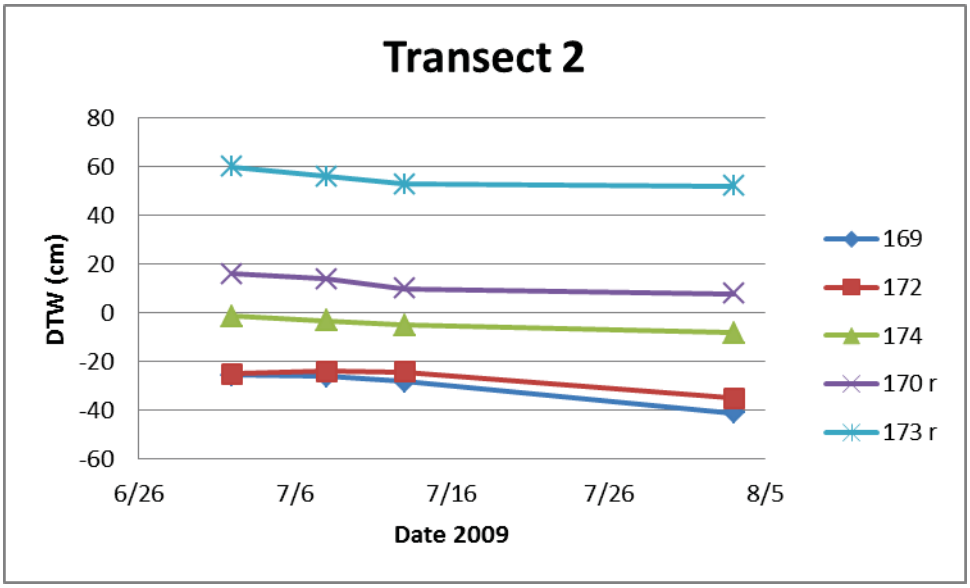


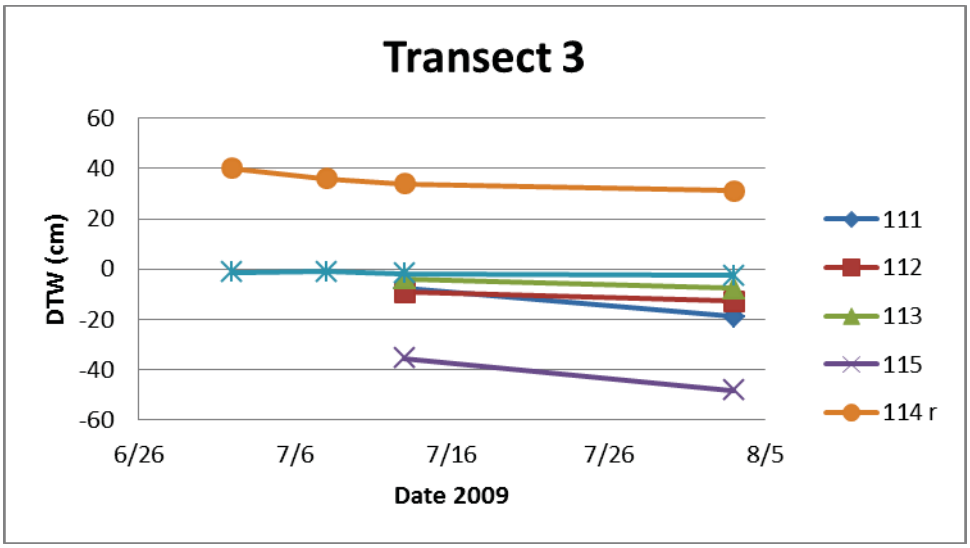
Figure 14. 2-dimensional cross section of transect 9 shown in Figure 1. This cross section describes a somewhat stable ground surface combined with monthly variations in 2010 depth to groundwater collected from the groundwater monitoring wells.



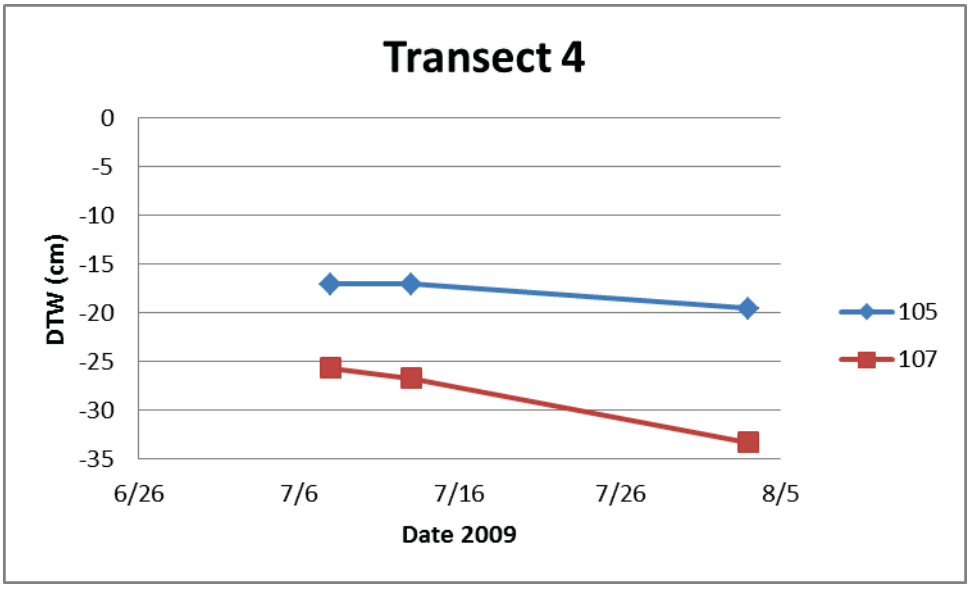
Figures 15. Depth to water table hydrographs for the 2010 season in Lulu City Wetland along transect 1 (Zone 4). This hydrograph describes a steadily lowering water table as the season progresses.



Figures 16. Depth to water table hydrographs for the 2010 season in Lulu City Wetland along transect 2 (Zone 4). This hydrograph describes a steadily lowering water table as the season progresses.



Figures 17. Depth to water table hydrographs for the 2010 season in Lulu City Wetland along transect 3 (Zone 4). This hydrograph describes a steadily lowering water table as the season progresses.



Figures 18. Depth to water table hydrographs for the 2010 season in Lulu City Wetland along transect 4 (Zone 4). This hydrograph describes a steadily lowering water table as the season progresses.

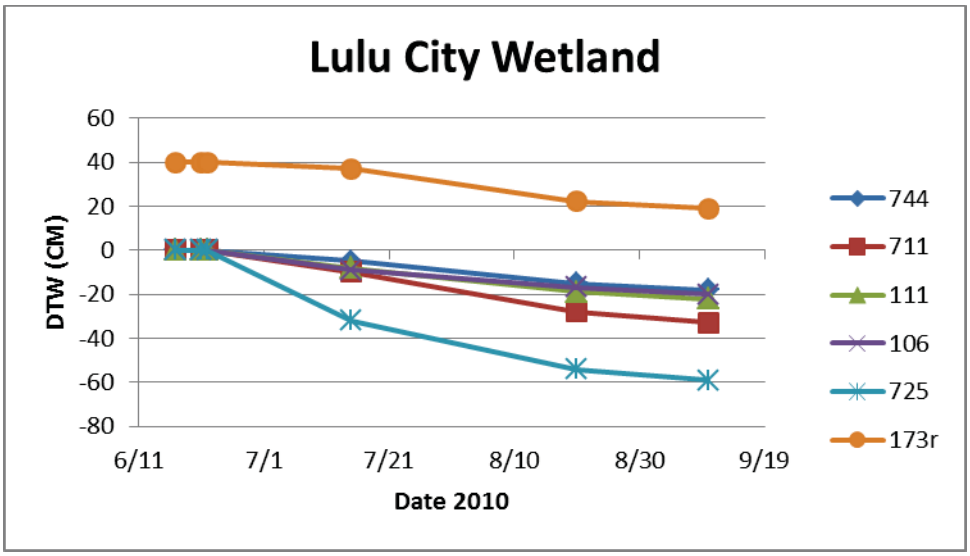


Figure 19. Depth to water table hydrographs for the 2010 season in Lulu City Wetland (Zone 4). This hydrograph describes a steadily lowering water table as the season progresses.

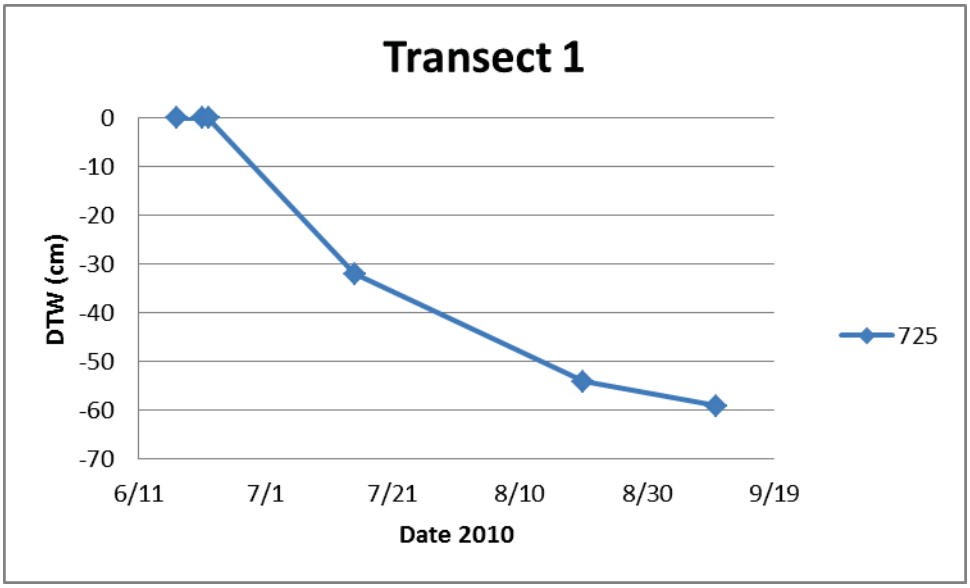


Figure 20. Depth to water table hydrographs for the 2010 season in Lulu City Wetland along transect 1 (Zone 4). This hydrograph describes a steadily lowering water table as the season progresses.

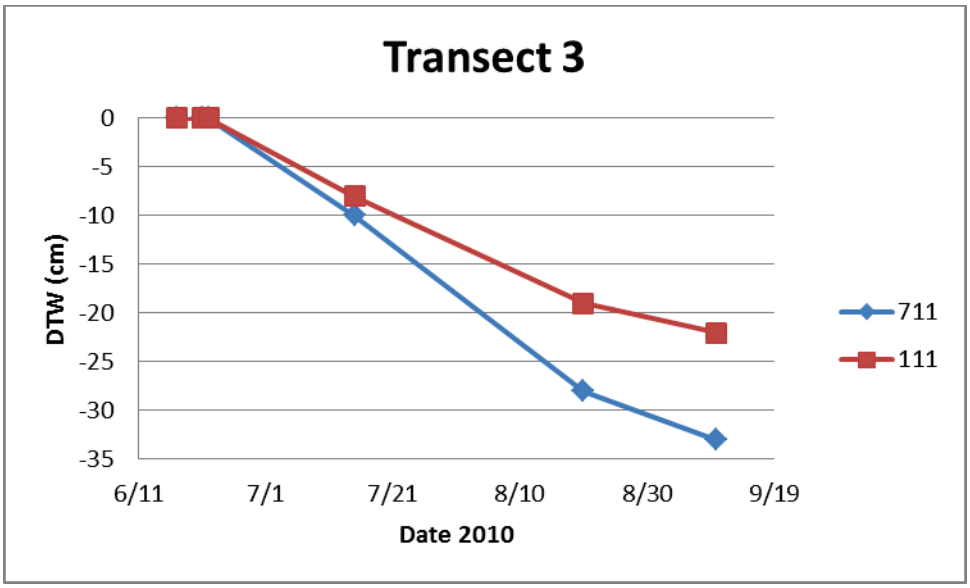


Figure 21. Depth to water table hydrographs for the 2010 season in Lulu City Wetland along transect 3 (Zone 4). This hydrograph describes a steadily lowering water table as the season progresses.

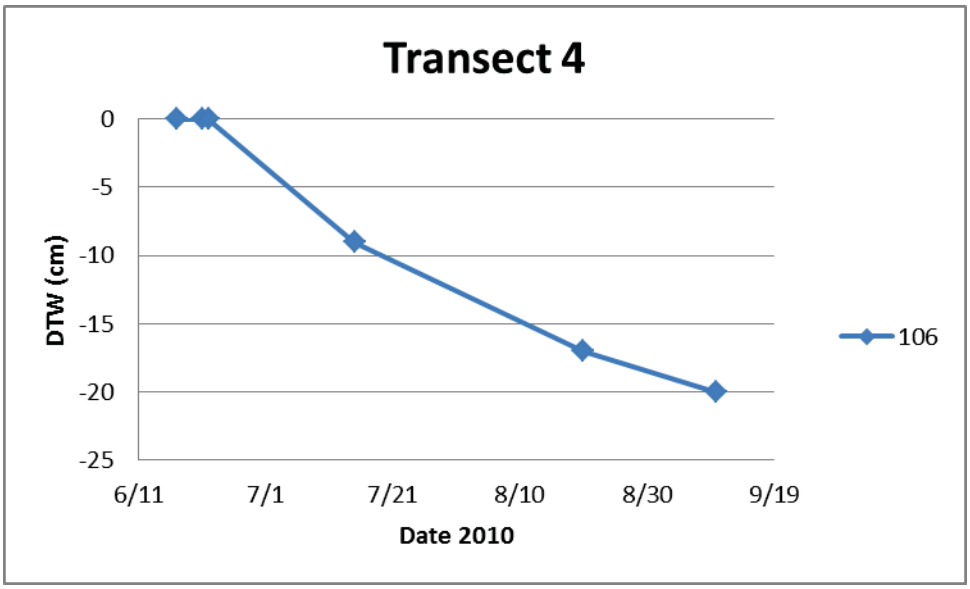
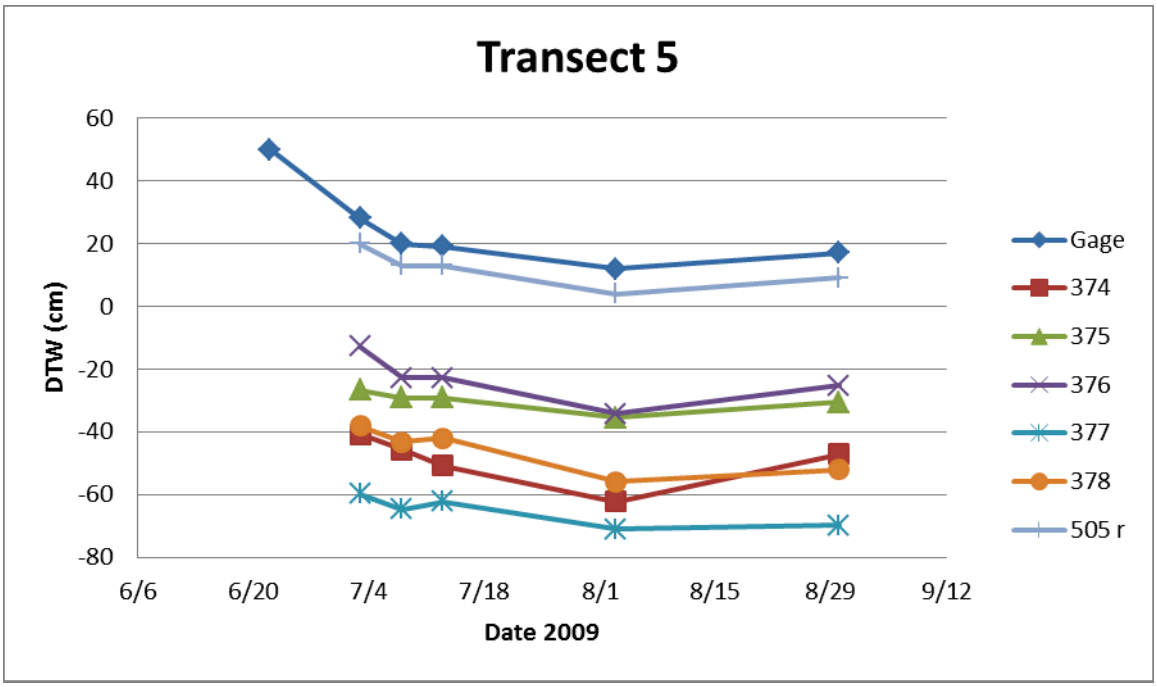
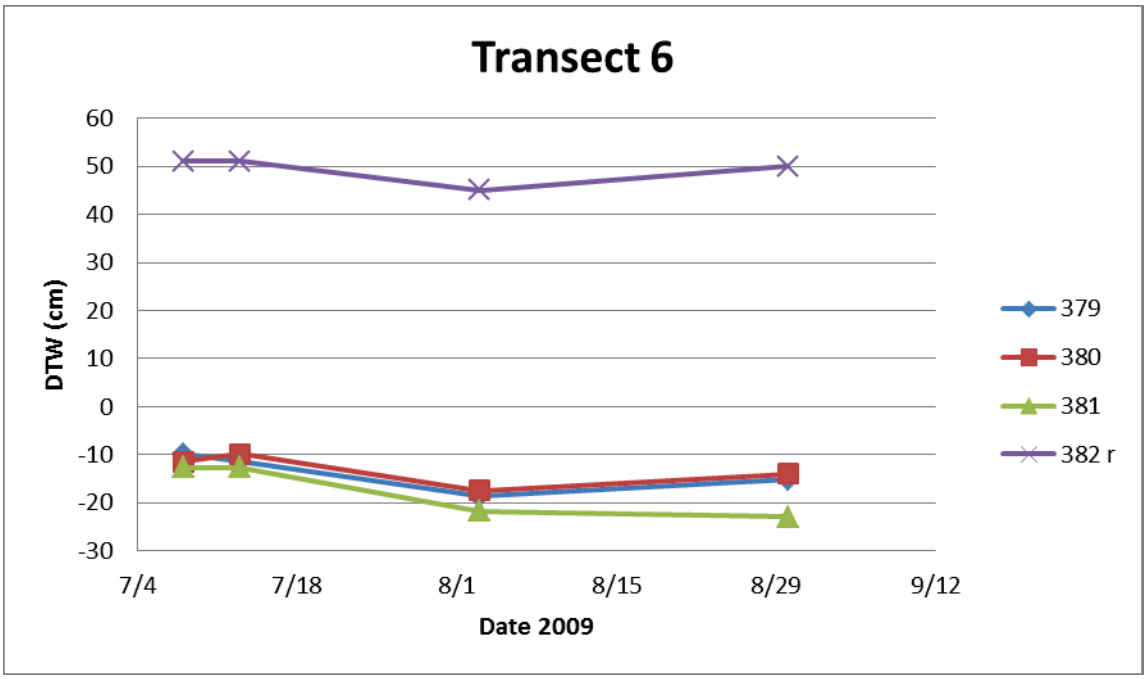


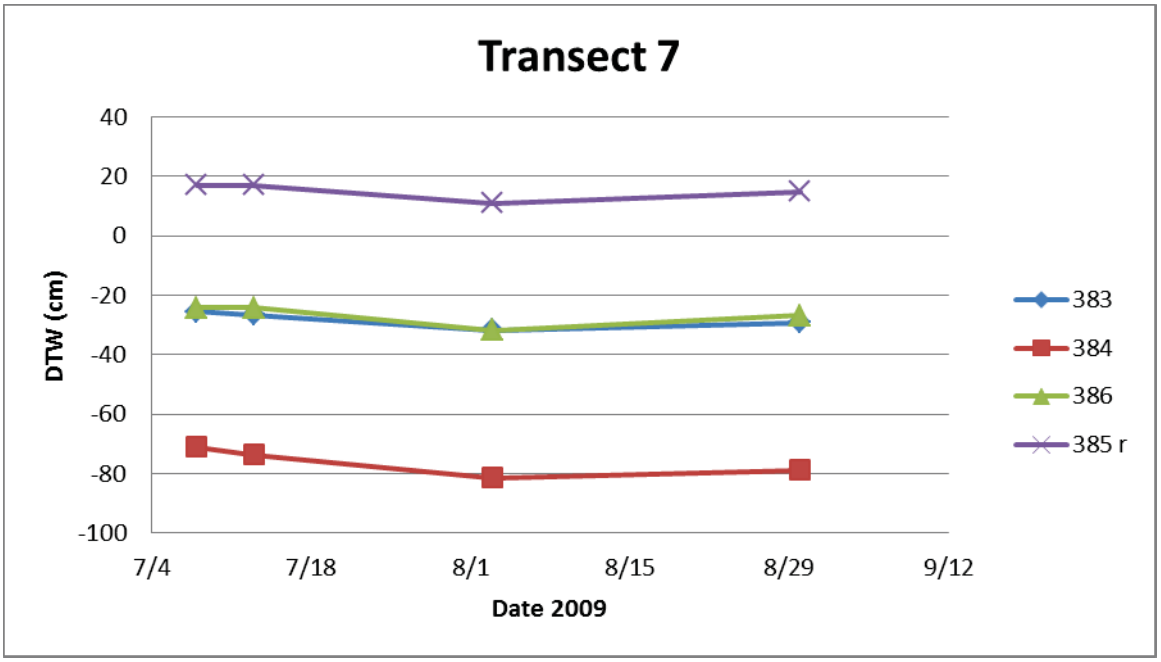
Figure 22. Depth to water table hydrographs for the 2010 season in Lulu City Wetland along transect 4 (Zone 4). This hydrograph describes a steadily lowering water table as the season progresses.



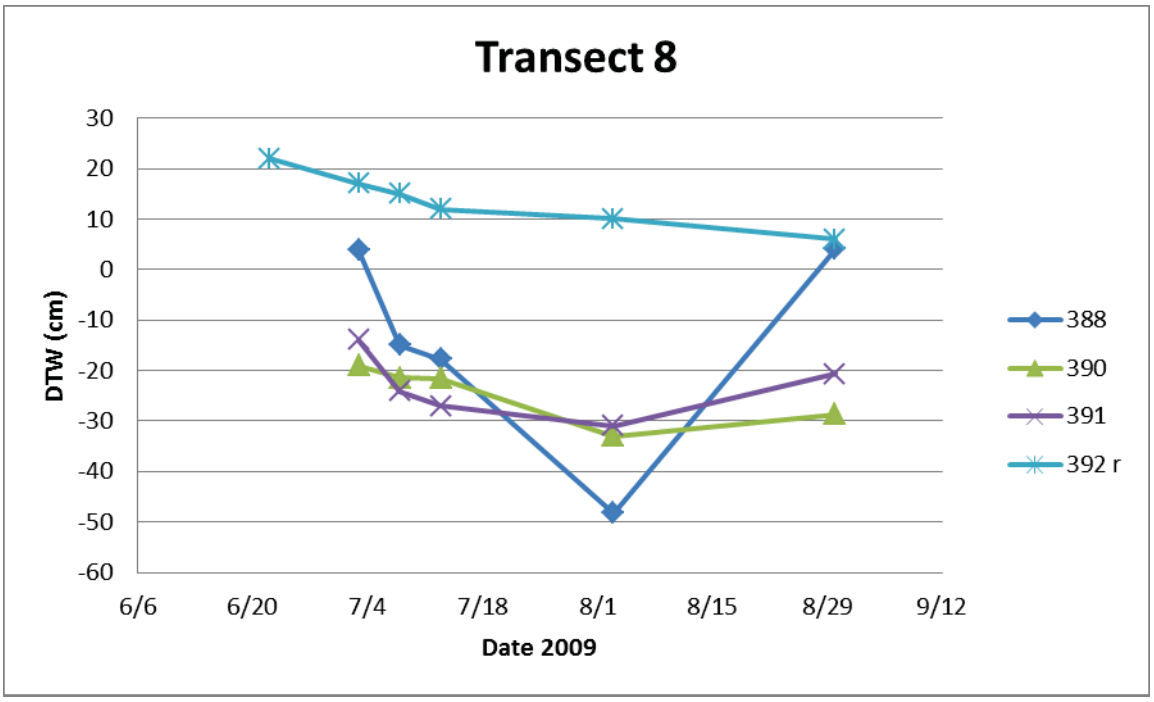
Figures 23. Depth to water table hydrographs for the 2009 season in Zone 3 along transect 5. This hydrograph describes a steadily lowering water table as the season progresses until an interestingly uniform increase in water table at the end of August. This increase is likely due to increased precipitation from the summer monsoon and late season ditch releases.



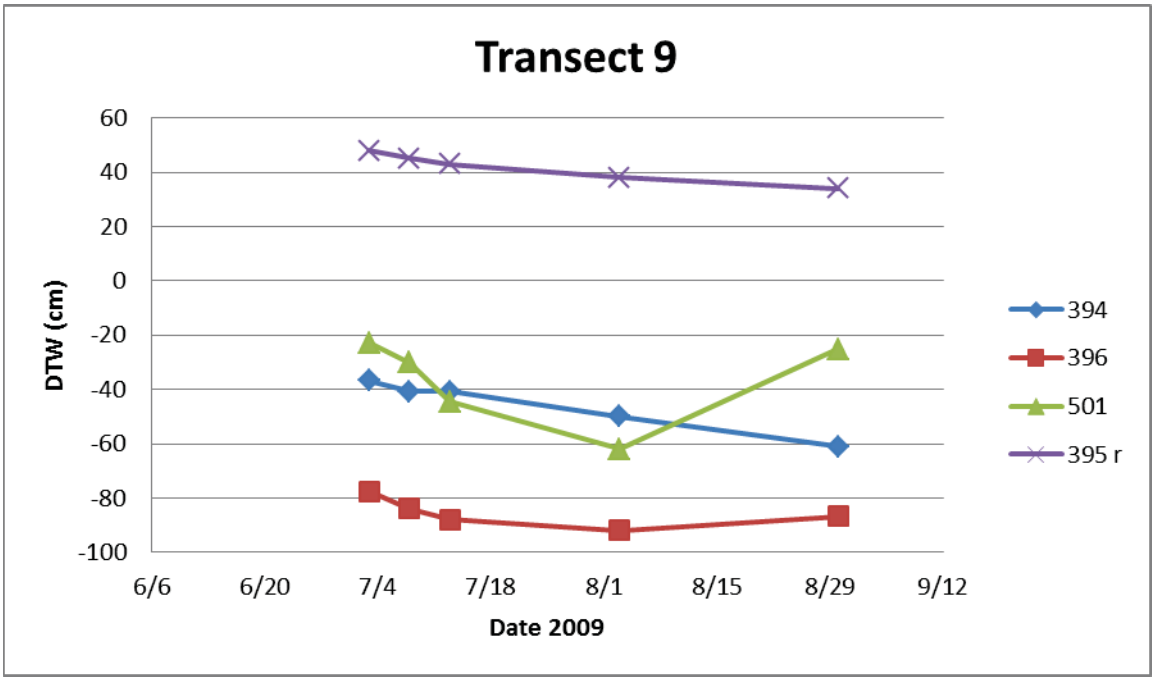
Figures 24. Depth to water table hydrographs for the 2009 season in Zone 3 along transect 6. This hydrograph describes a steadily lowering water table as the season progresses until an interestingly uniform increase in water table at the end of August. This increase is likely due to increased precipitation from the summer monsoon and late season ditch releases.



Figures 25. Depth to water table hydrographs for the 2009 season in Zone 3 along transect 7. This hydrograph describes a steadily lowering water table as the season progresses until an interestingly uniform increase in water table at the end of August. This increase is likely due to increased precipitation from the summer monsoon and late season ditch releases.



Figures 26. Depth to water table hydrographs for the 2009 season in Zone 3 along transect 8. This hydrograph describes a steadily lowering water table as the season progresses until an interestingly uniform increase in water table at the end of August. This increase is likely due to increased precipitation from the summer monsoon and late season ditch releases.



Figures 27. Depth to water table hydrographs for the 2009 season in Zone 3 along transect 9. This hydrograph describes a steadily lowering water table as the season progresses until an interestingly uniform increase in water table at the end of August. This increase is likely due to increased precipitation from the summer monsoon and late season ditch releases.

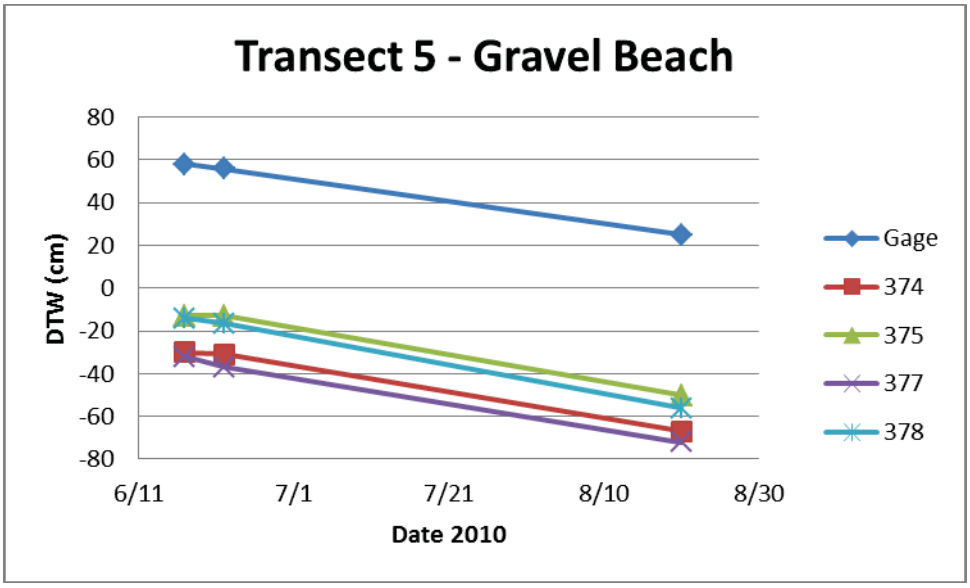


Figure 28. Depth to water table hydrographs for the 2010 season in Zone 3 along transects 5. This hydrograph describes a steadily lowering water table as the season progresses

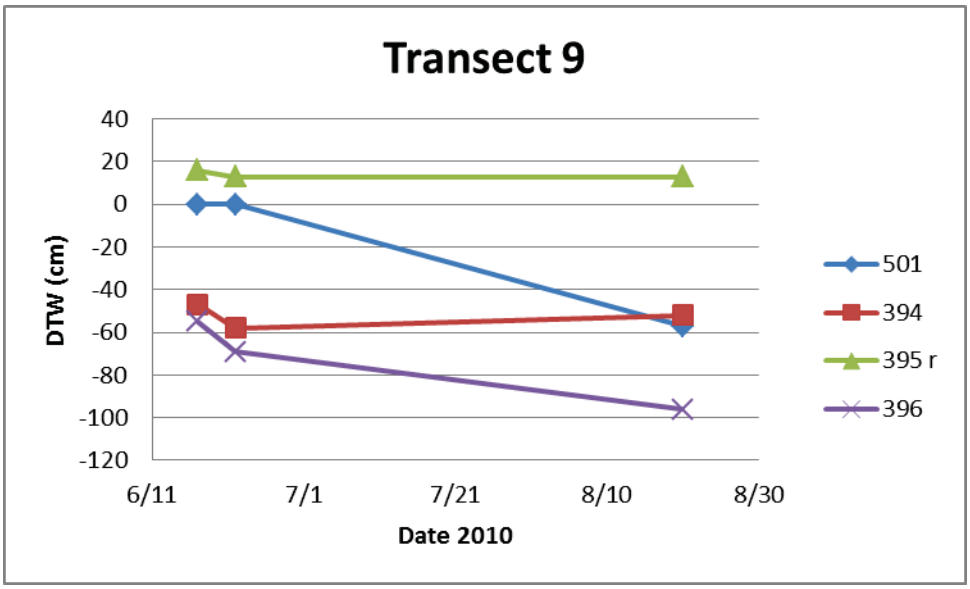


Figure 29. Depth to water table hydrographs for the 2010 season in Zone 3 along transects 9. This hydrograph describes a steadily lowering water table as the season progresses except for well 394 that is likely groundwater fed and not affected by the seasonal decline in Colorado River stage.

Figure 30: Excavating sediment pits in the Lulu City Wetland. September 2009.

Figure 31: Stratigraphic interpretations of the sediment pits revealed multiple debris events with variable particle size and buried vegetation layers.

Pit 1

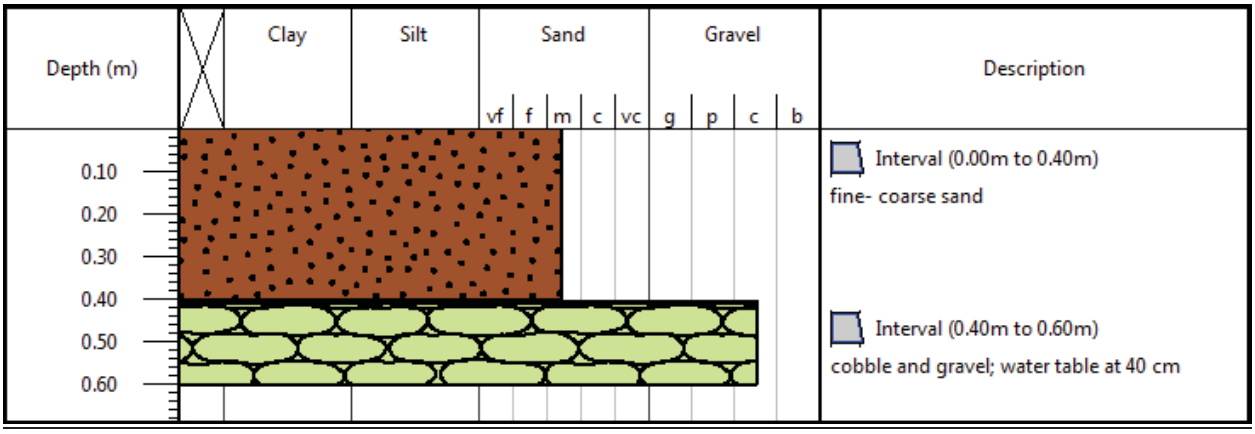


Figure 32: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit 2

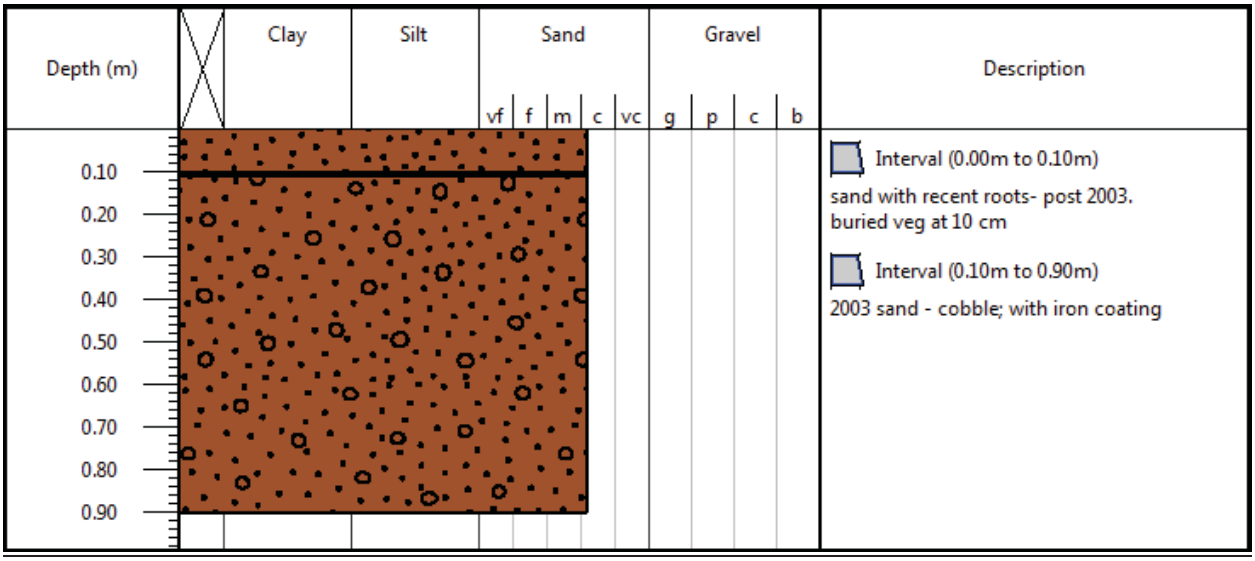


Figure 33: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit 3

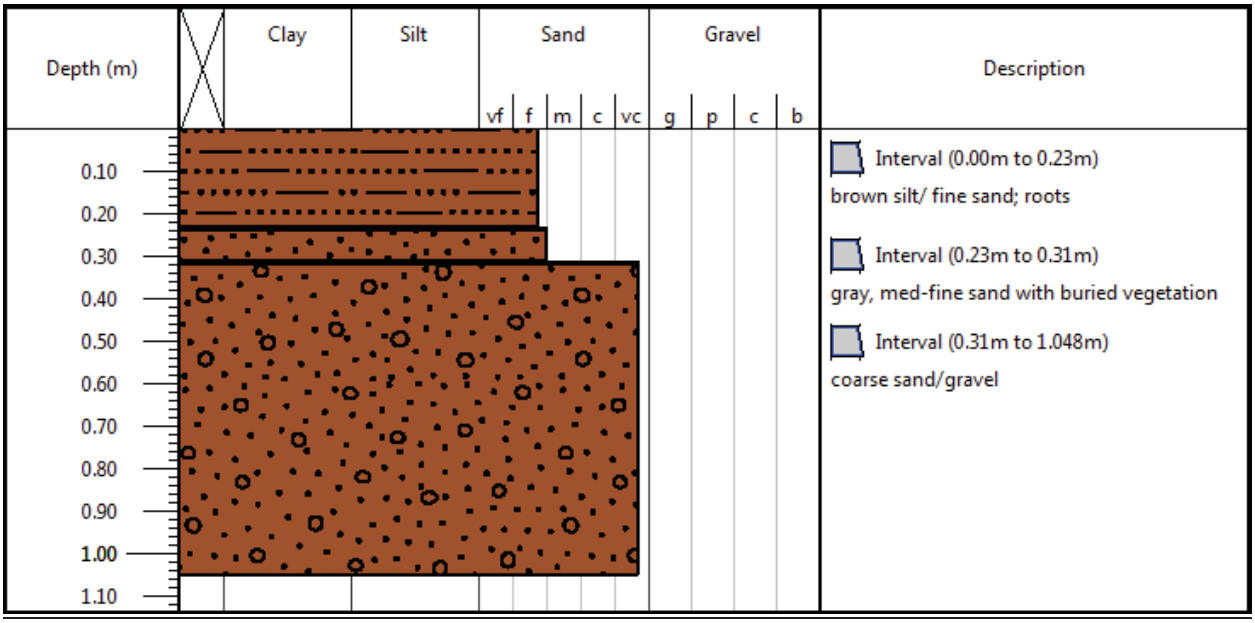


Figure 34: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit 4

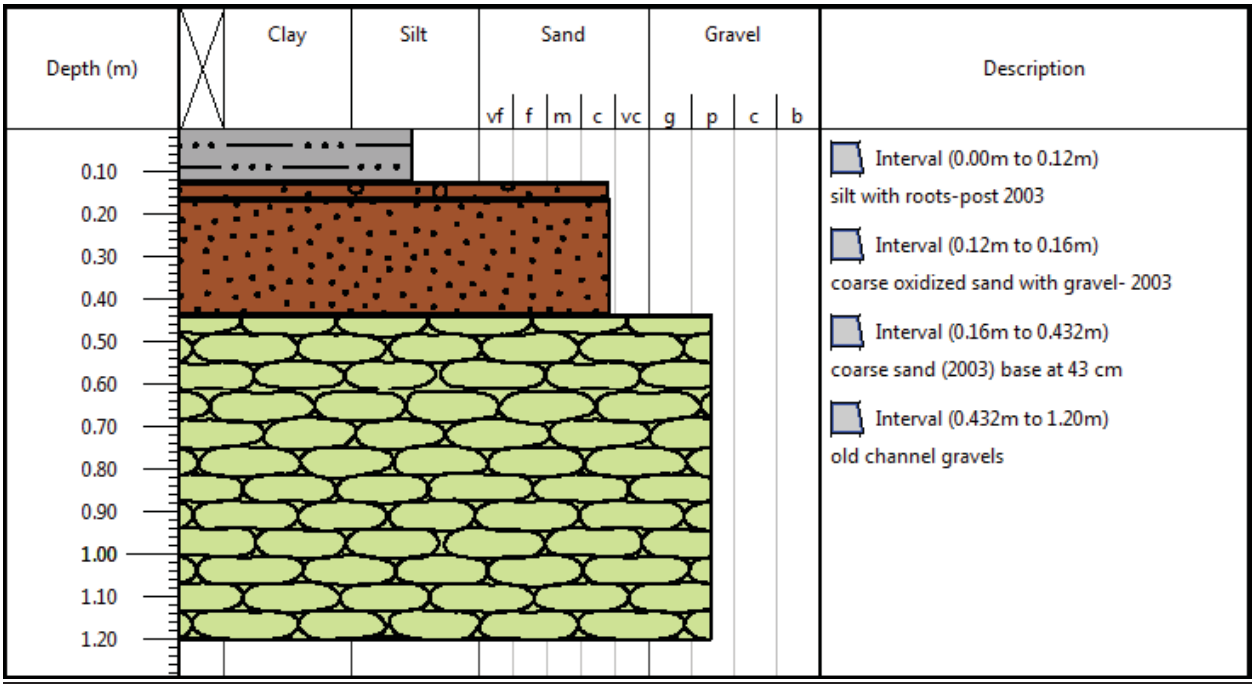


Figure 35: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit

5

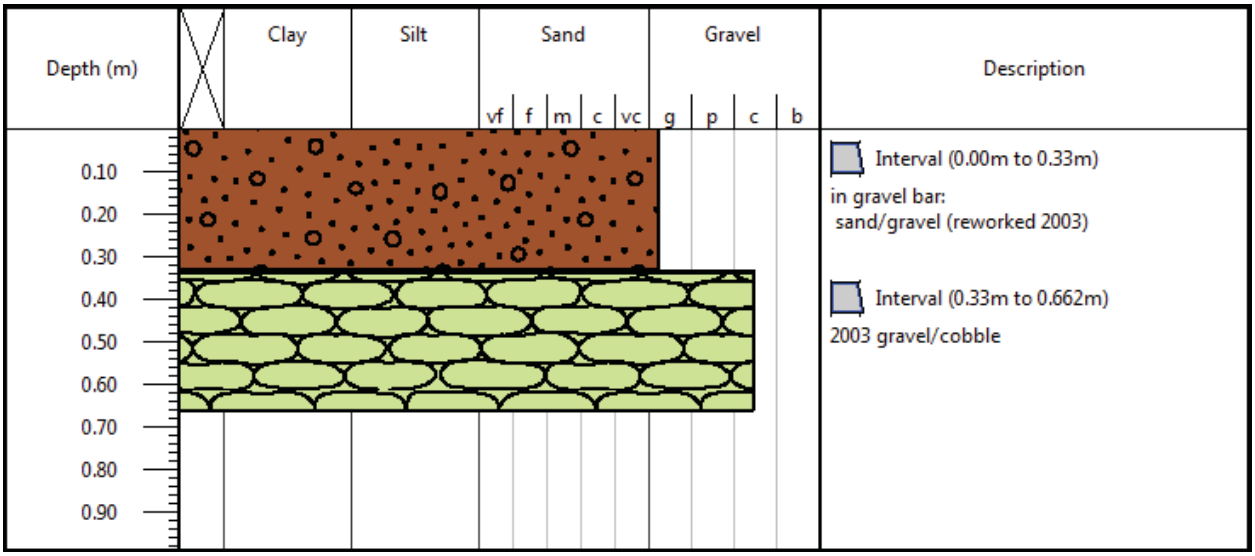


Figure 36: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit 6

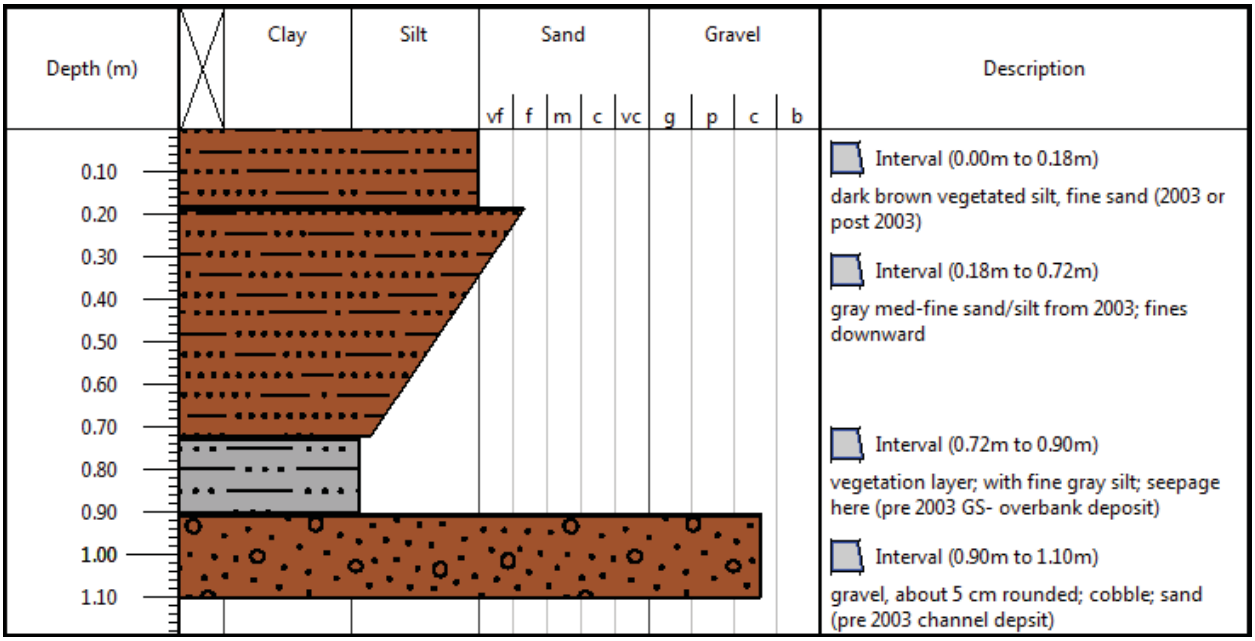


Figure 37: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit 7

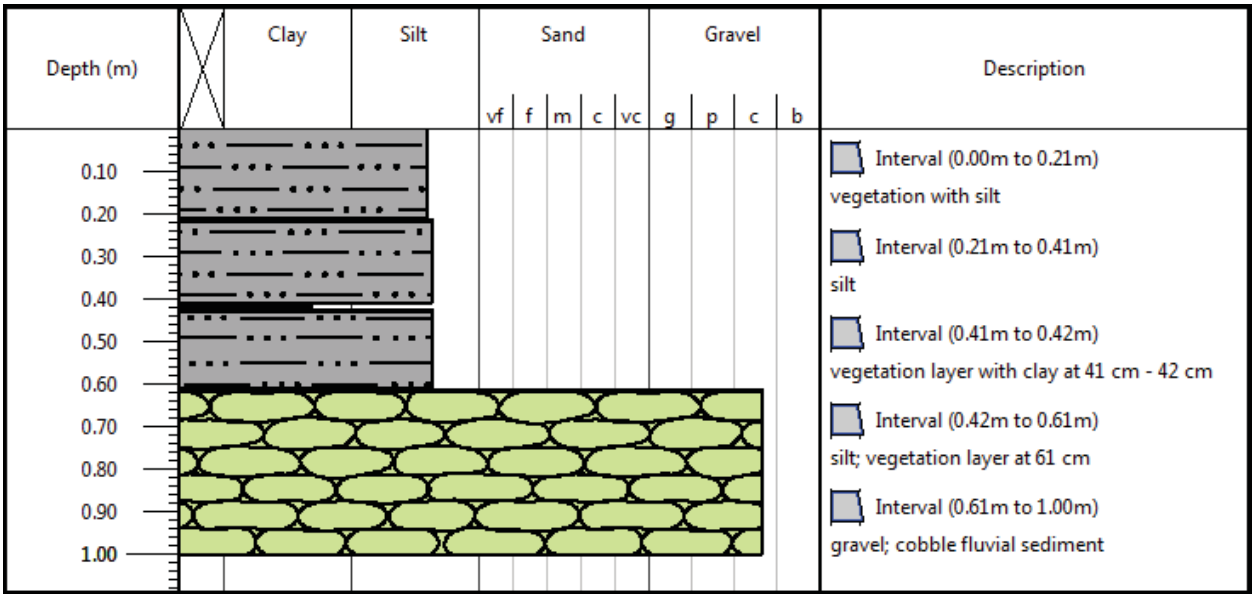


Figure 38: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit 8

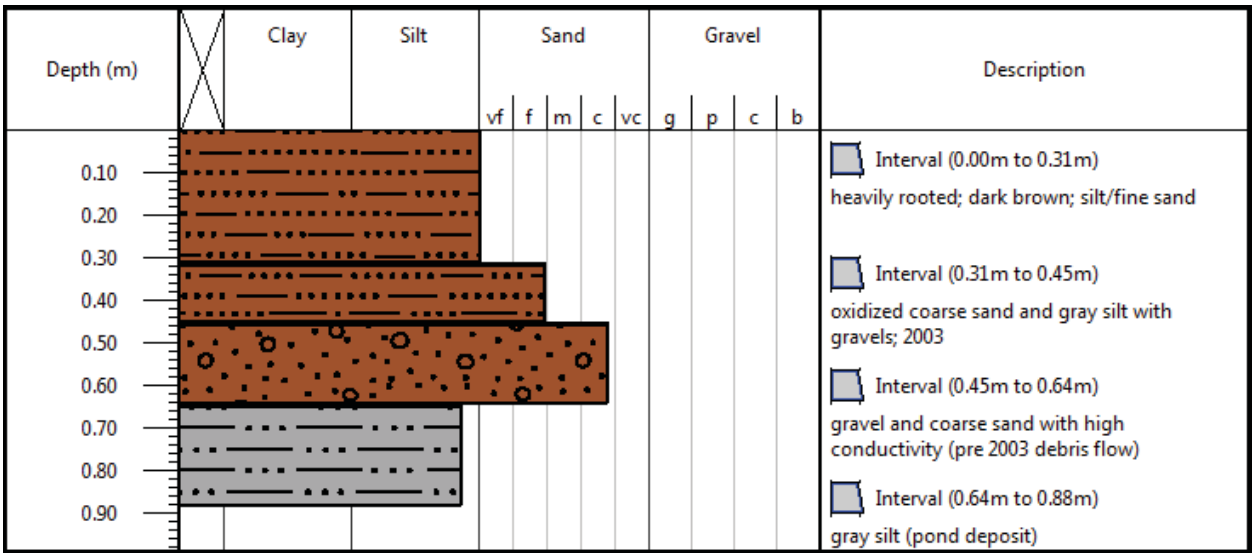


Figure 39: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
9

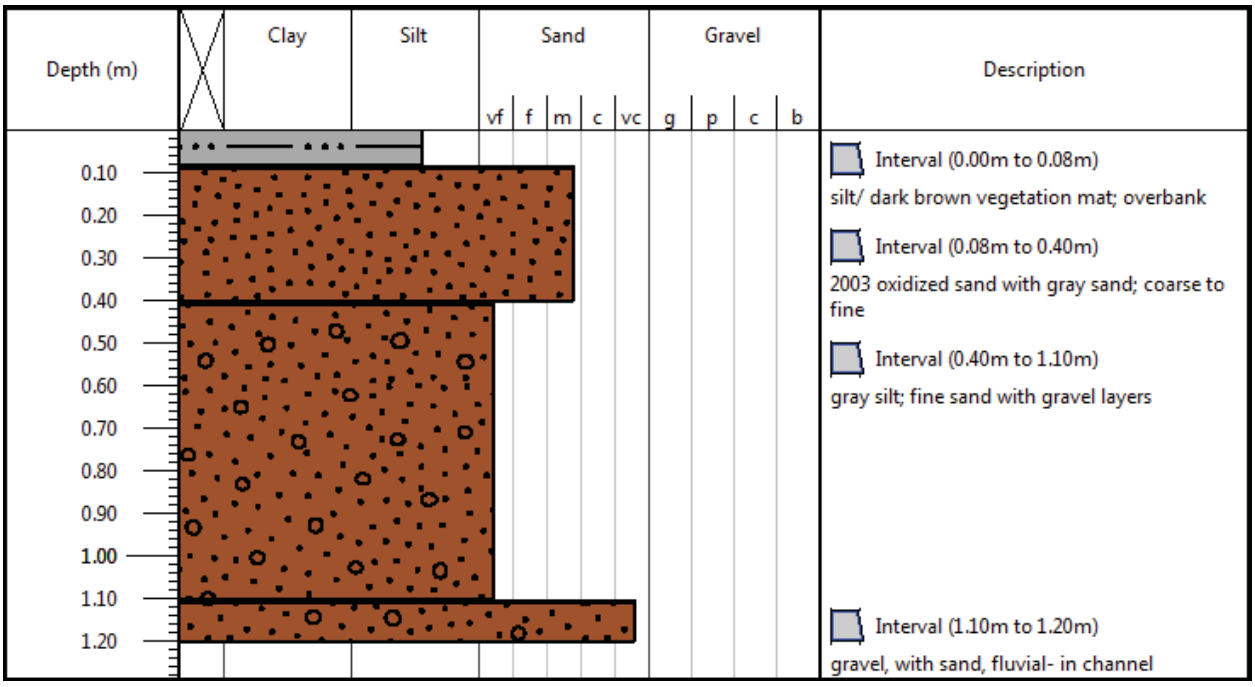


Figure 40: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit 10

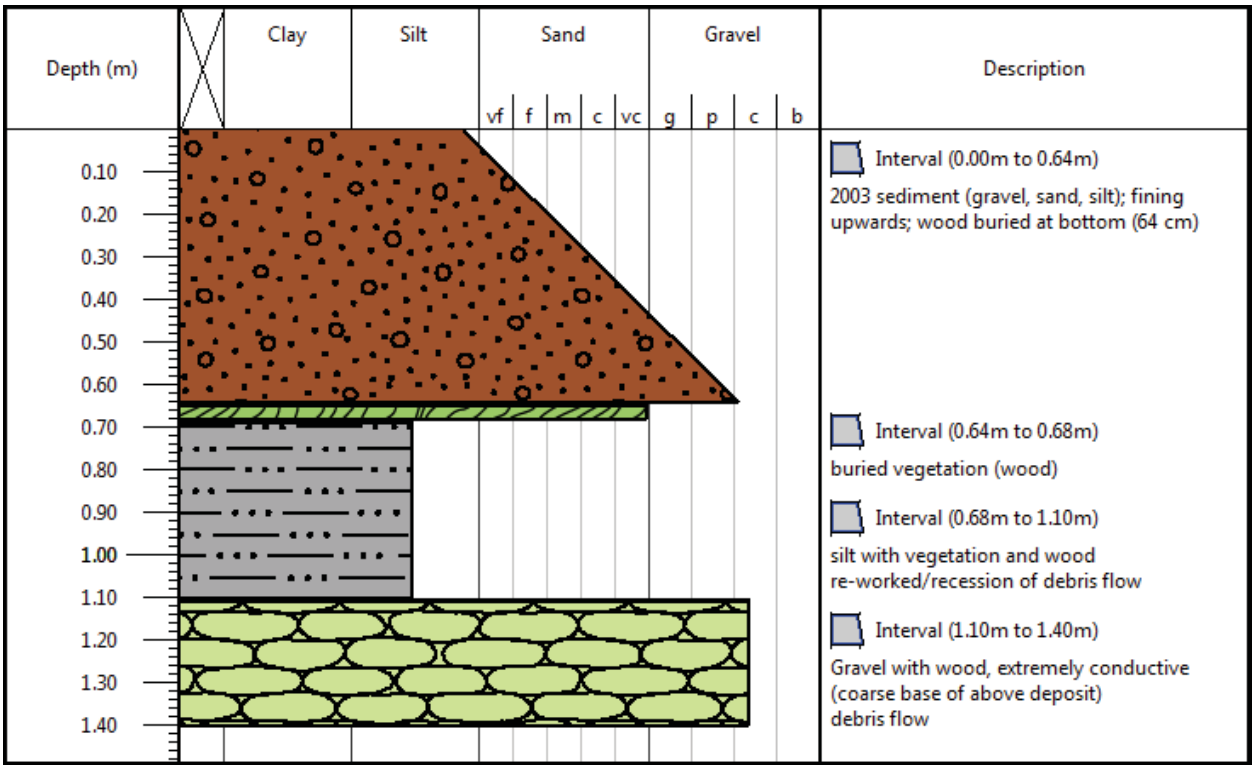


Figure 41: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
11

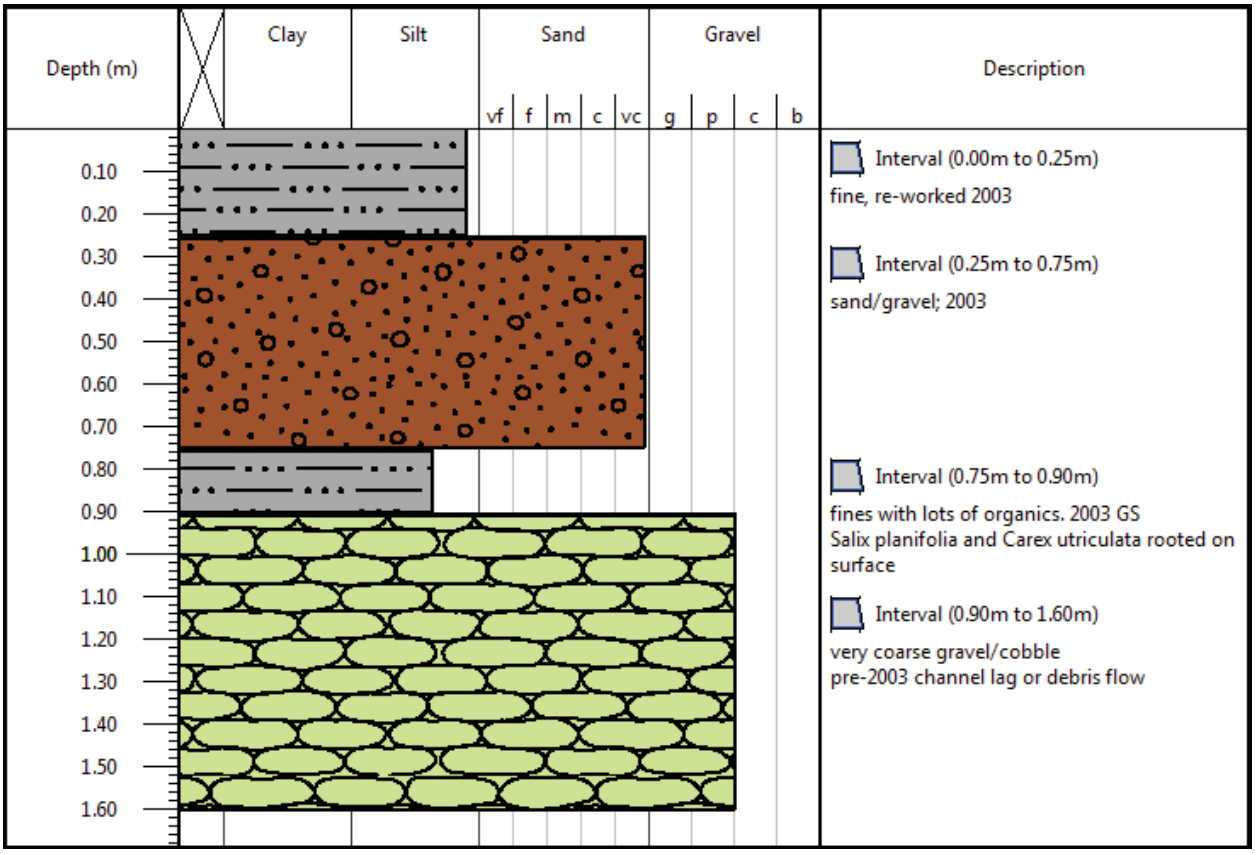


Figure 42: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit 12

Figure 43: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

No stratigraphic data for pit 12. Excavated two standing dead Lodgepole Pines from the hole. The germination crown of the small pine was 25 cm below the current ground surface and had approximately 20 annual growth rings. The germination crown of the large pine was 55 cm below the current ground surface and had approximately 45 annual growth rings.

Pit
13

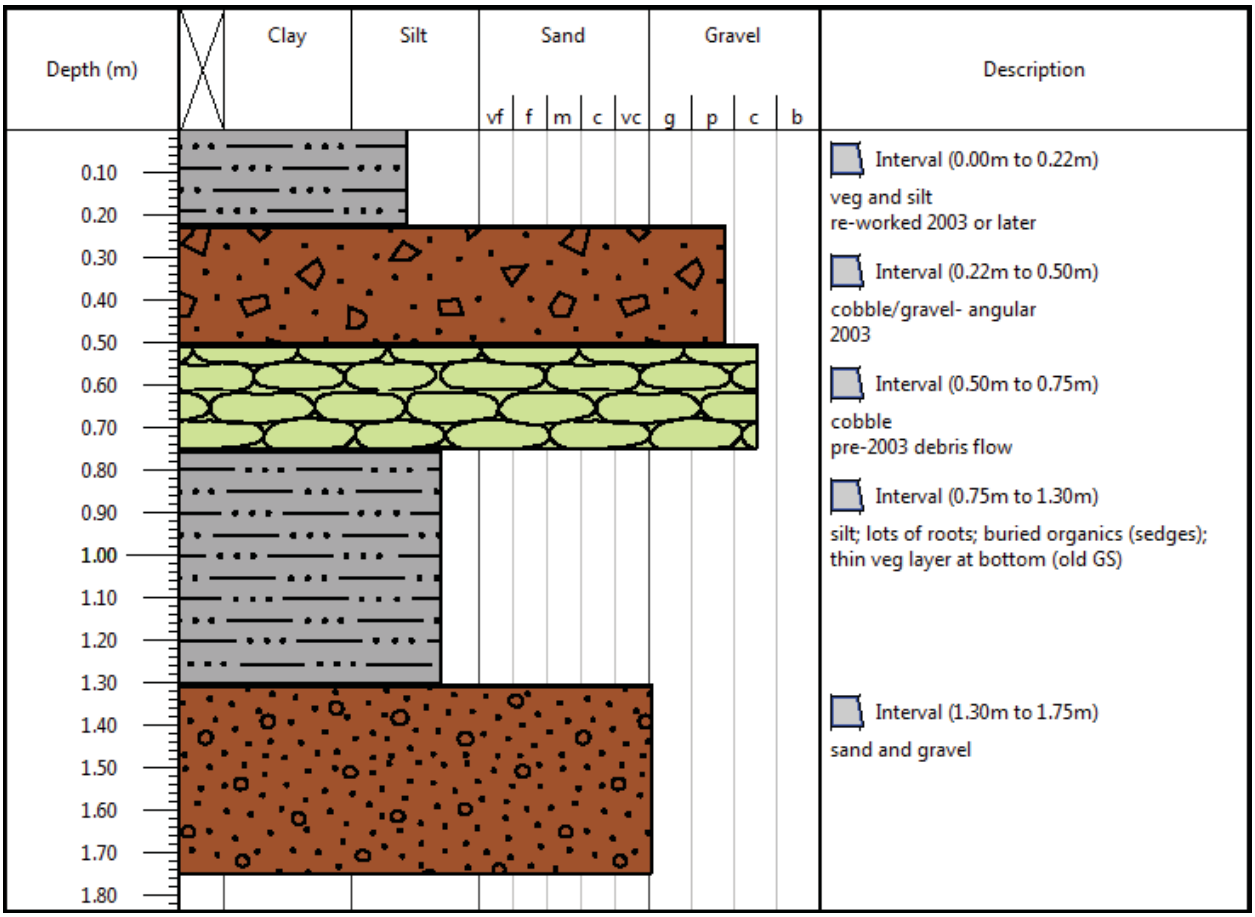


Figure 44: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
14

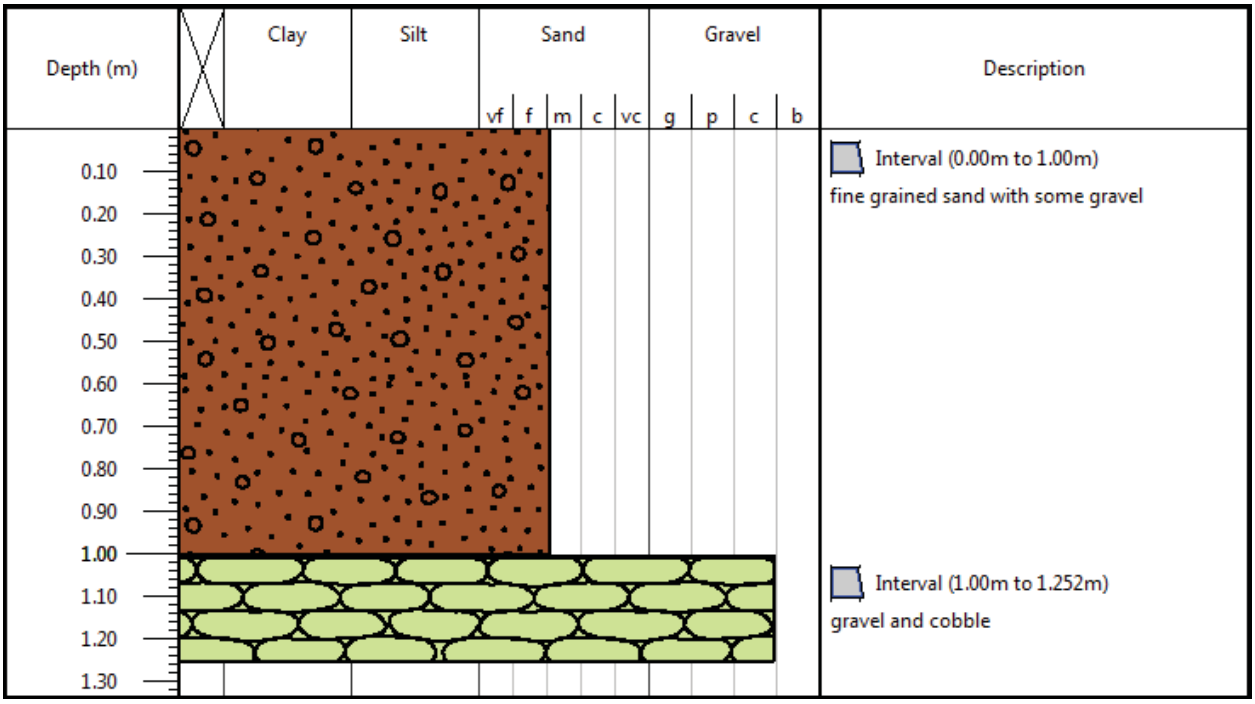


Figure 45: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
15

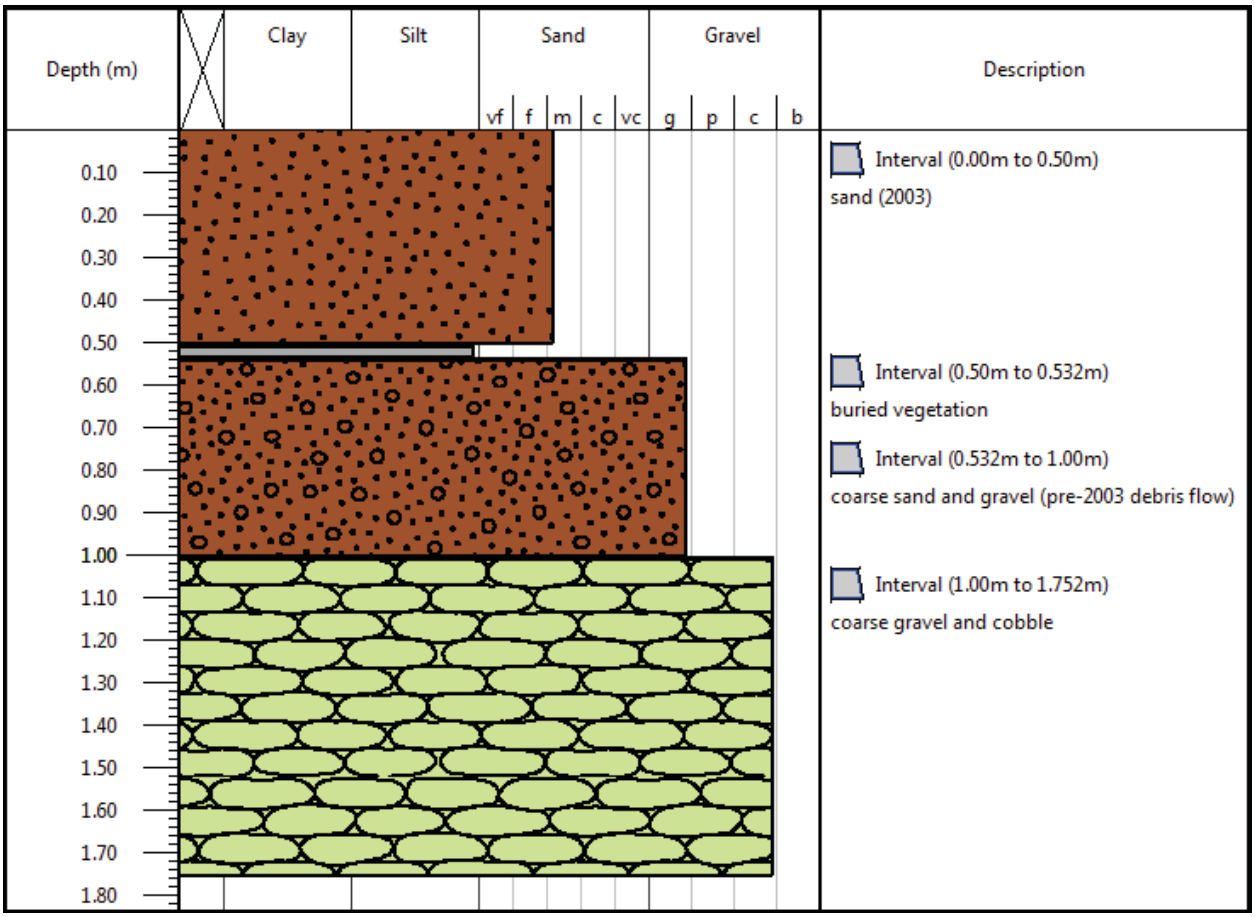


Figure 46: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
16

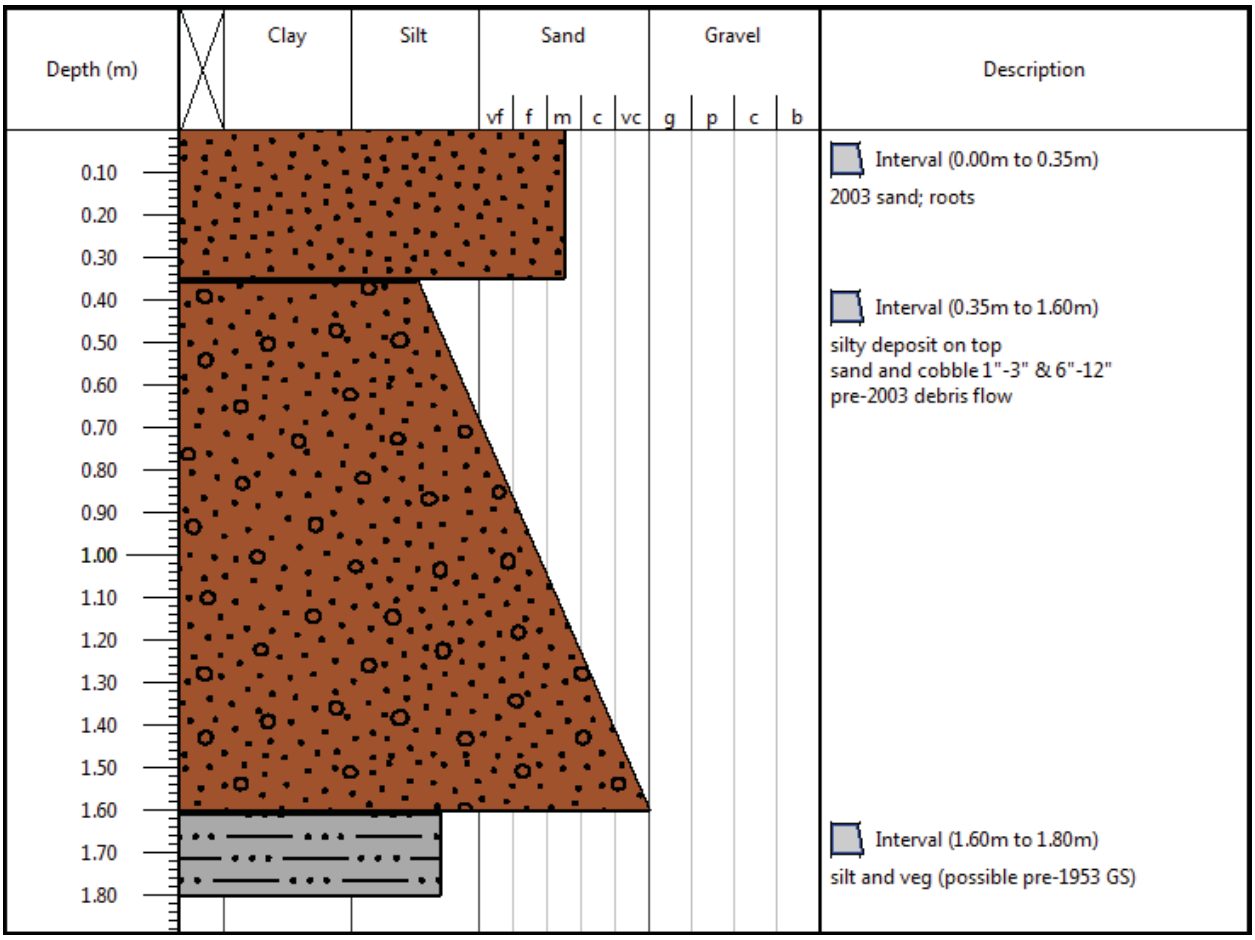


Figure 47: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
17

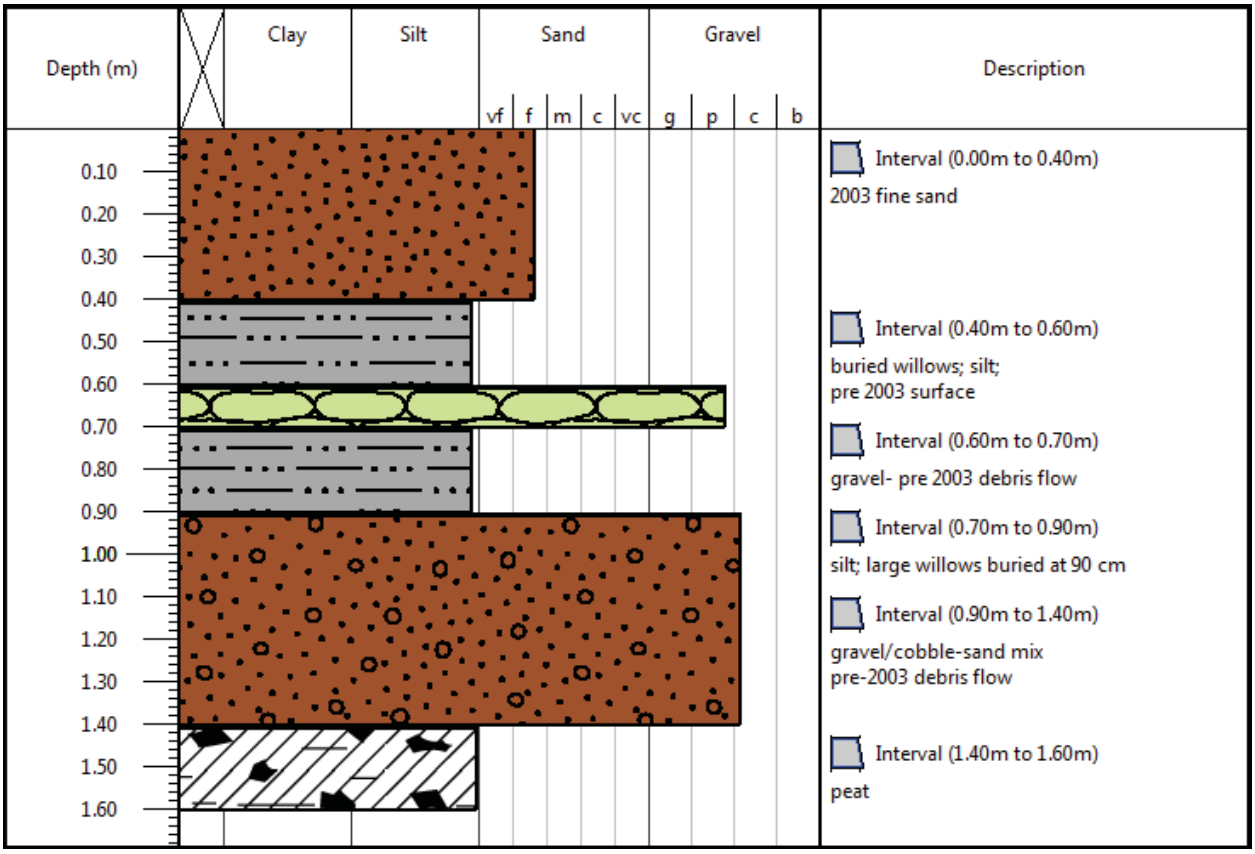


Figure 48: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit 18

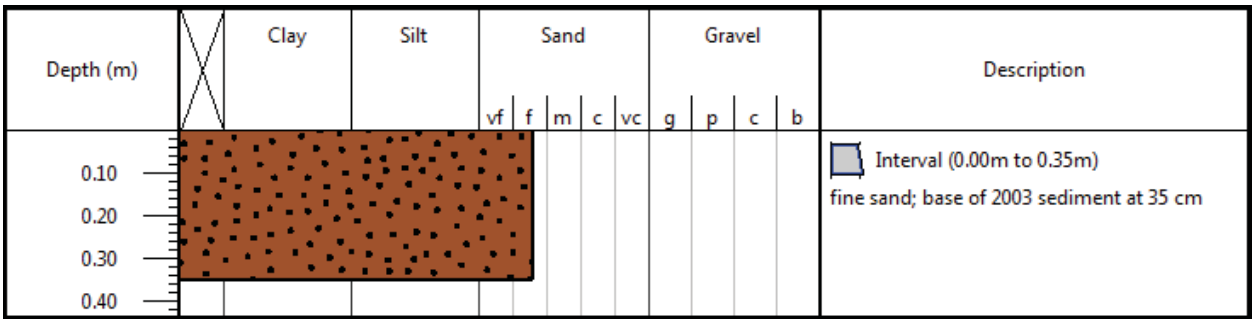


Figure 49: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
19

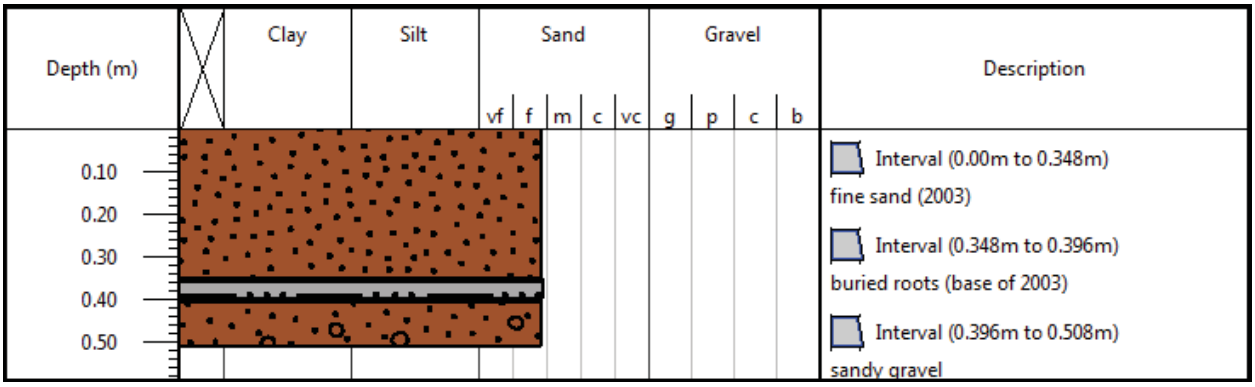


Figure 50: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit 20

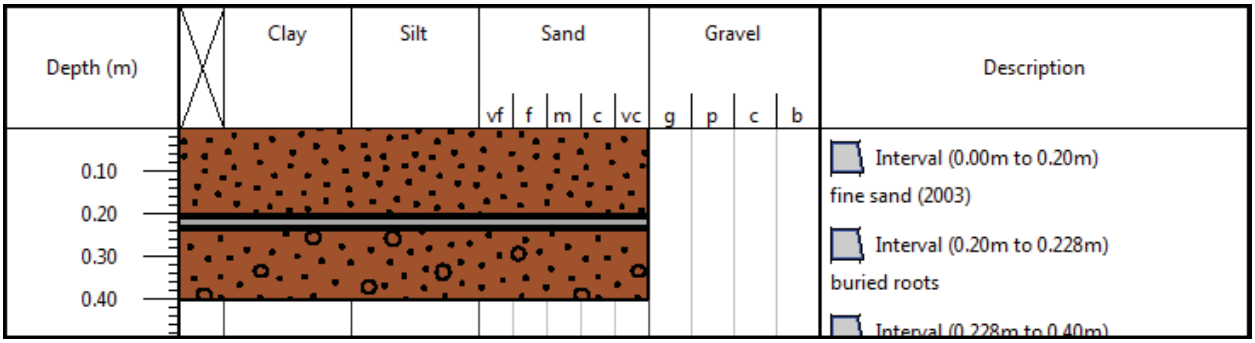


Figure 51: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
21

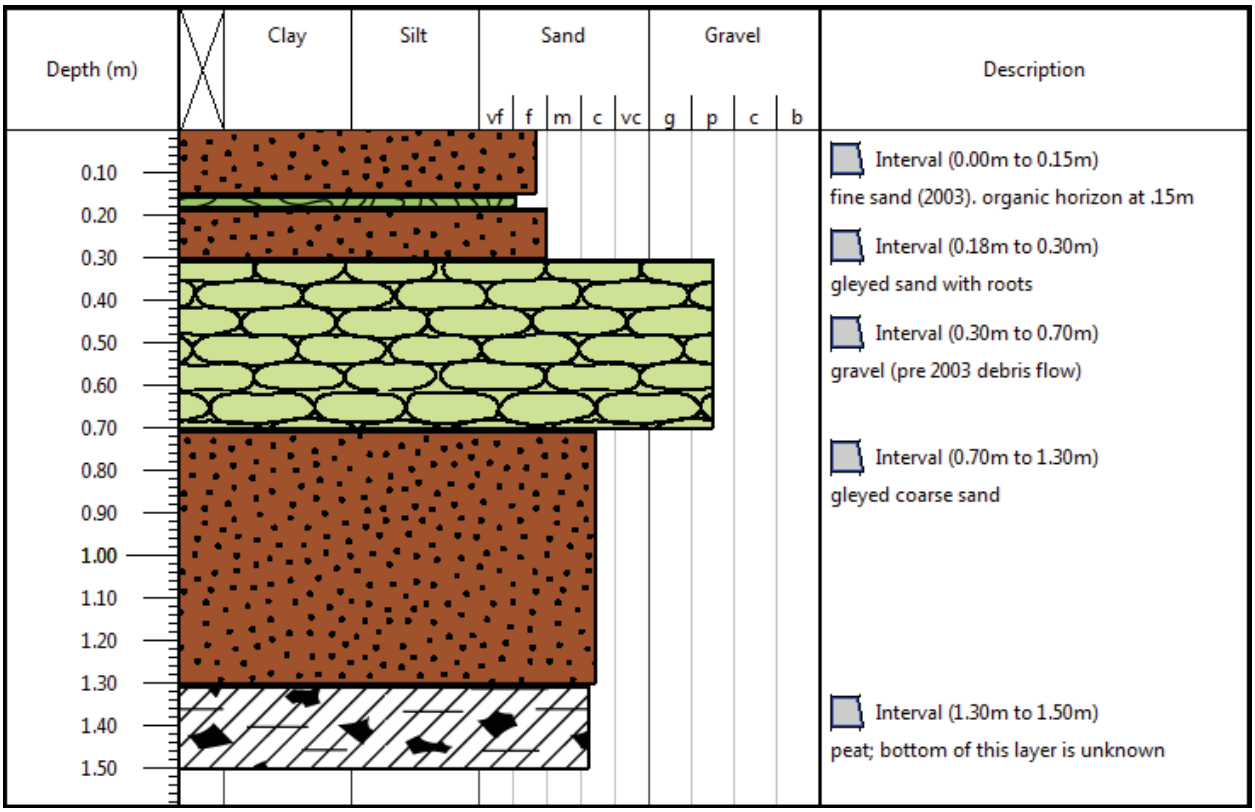


Figure 52: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
22

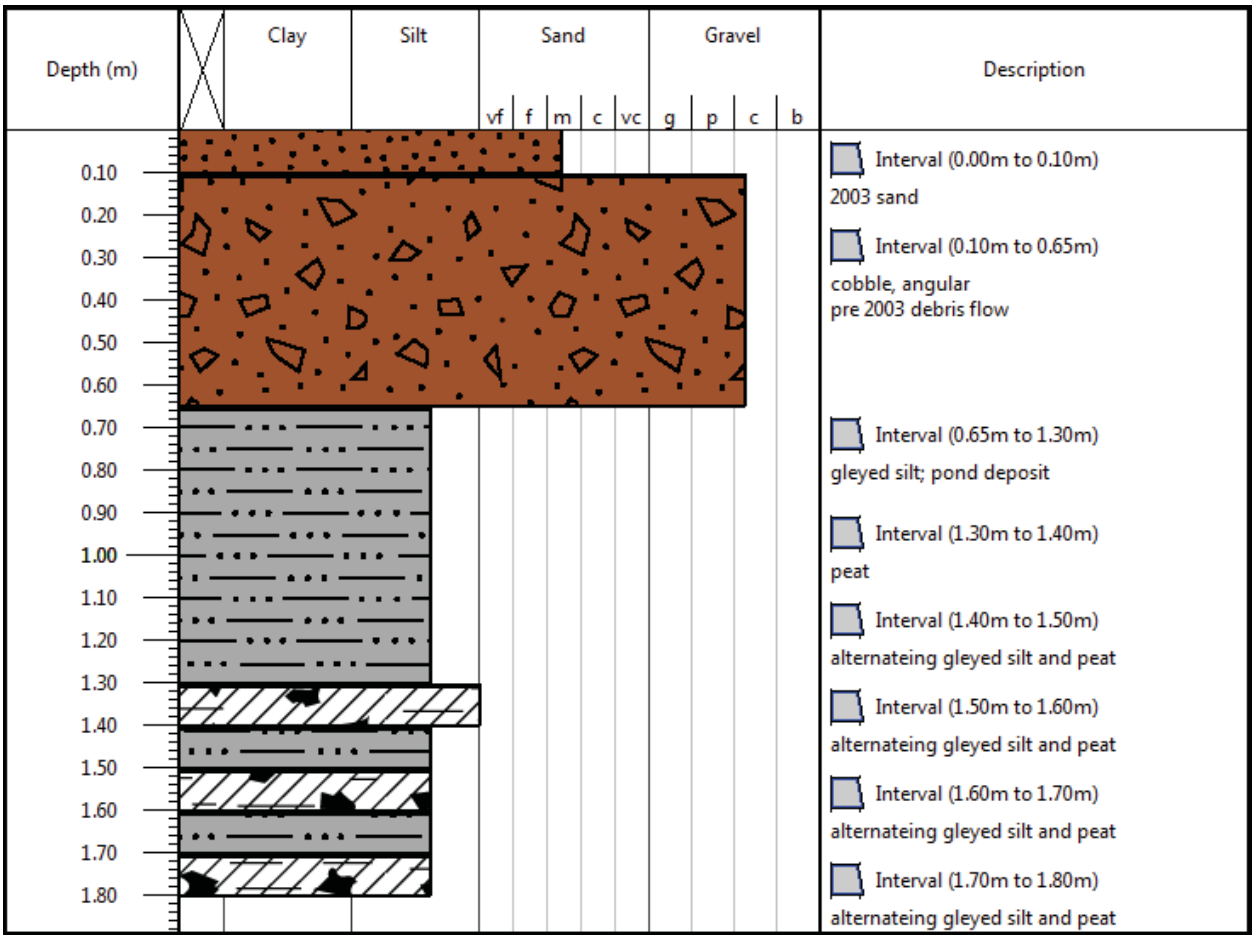


Figure 53: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
23

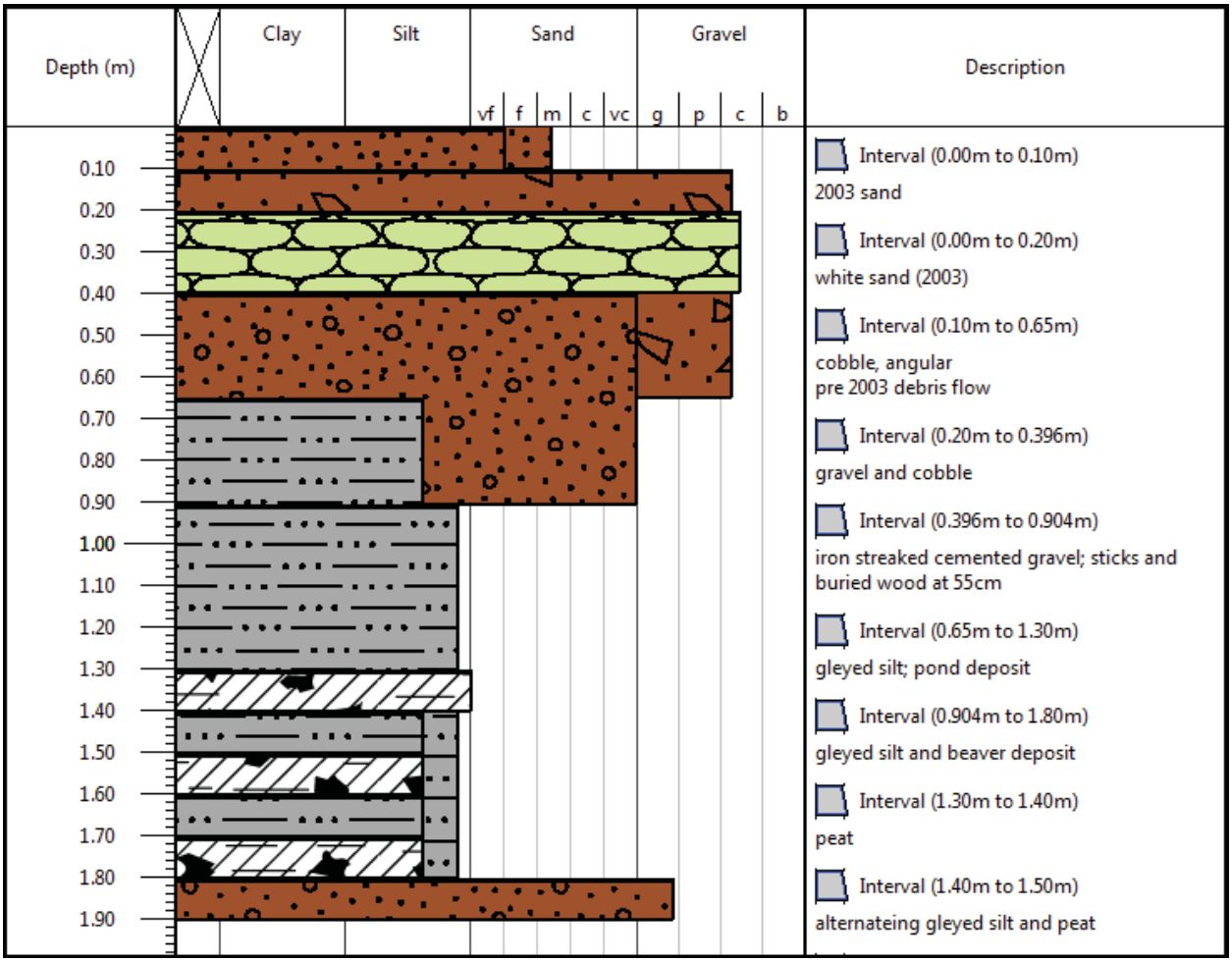


Figure 54: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit 24

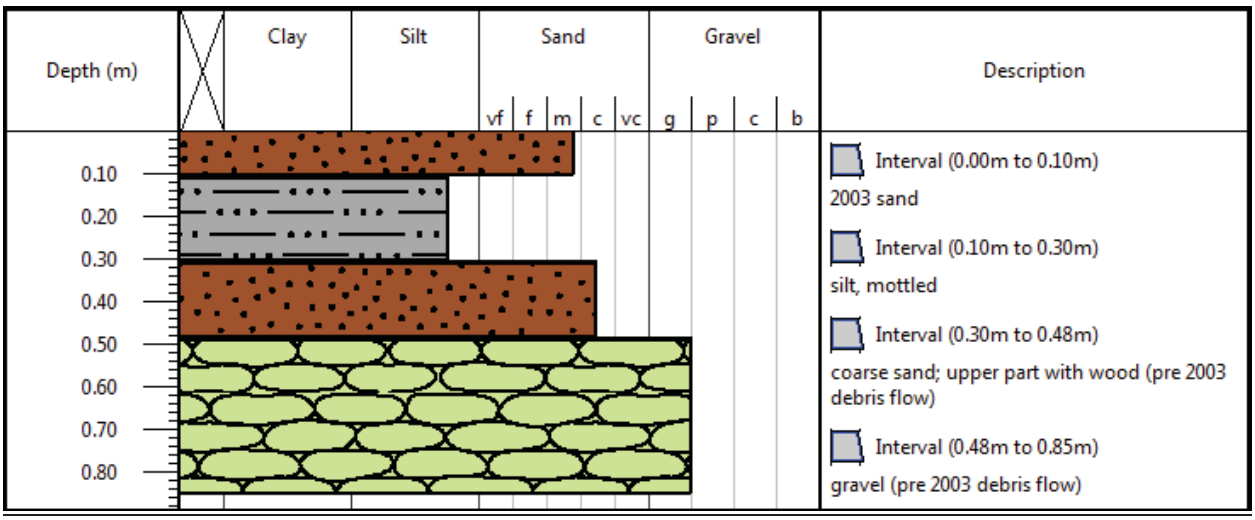


Figure 55: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
25

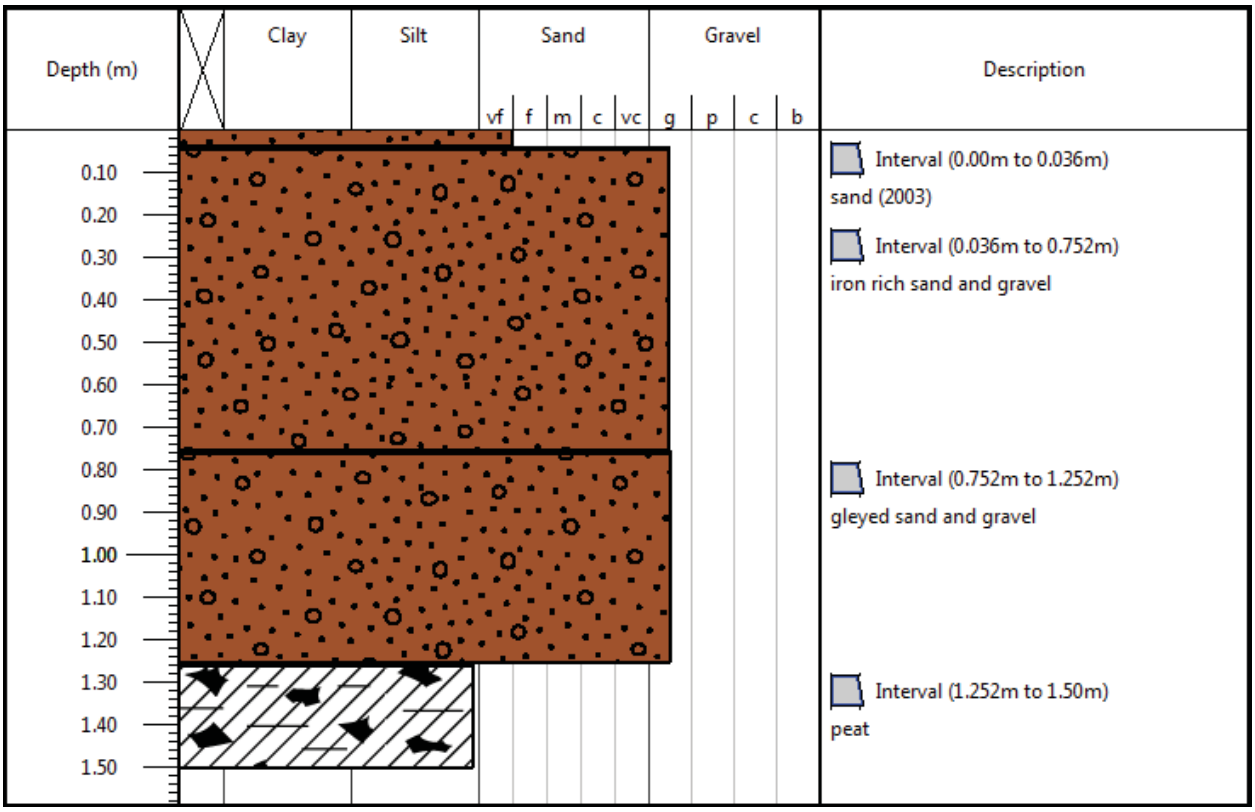


Figure 56: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
26

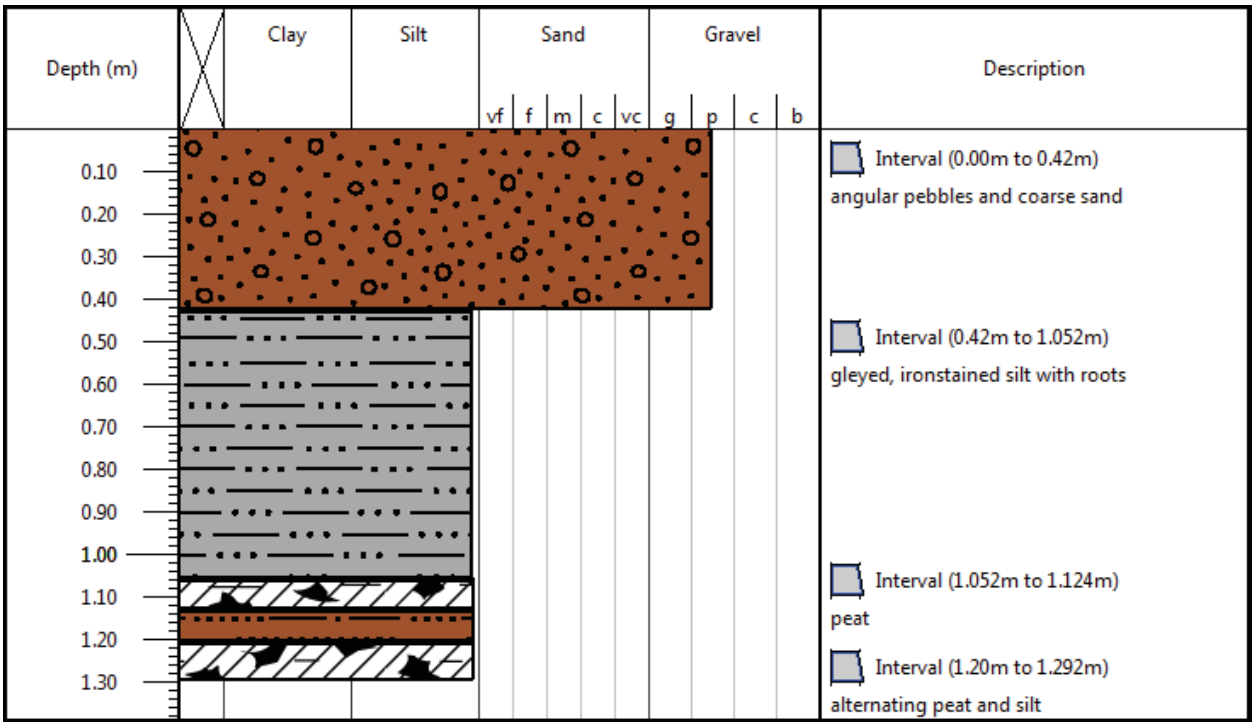


Figure 57: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit 27

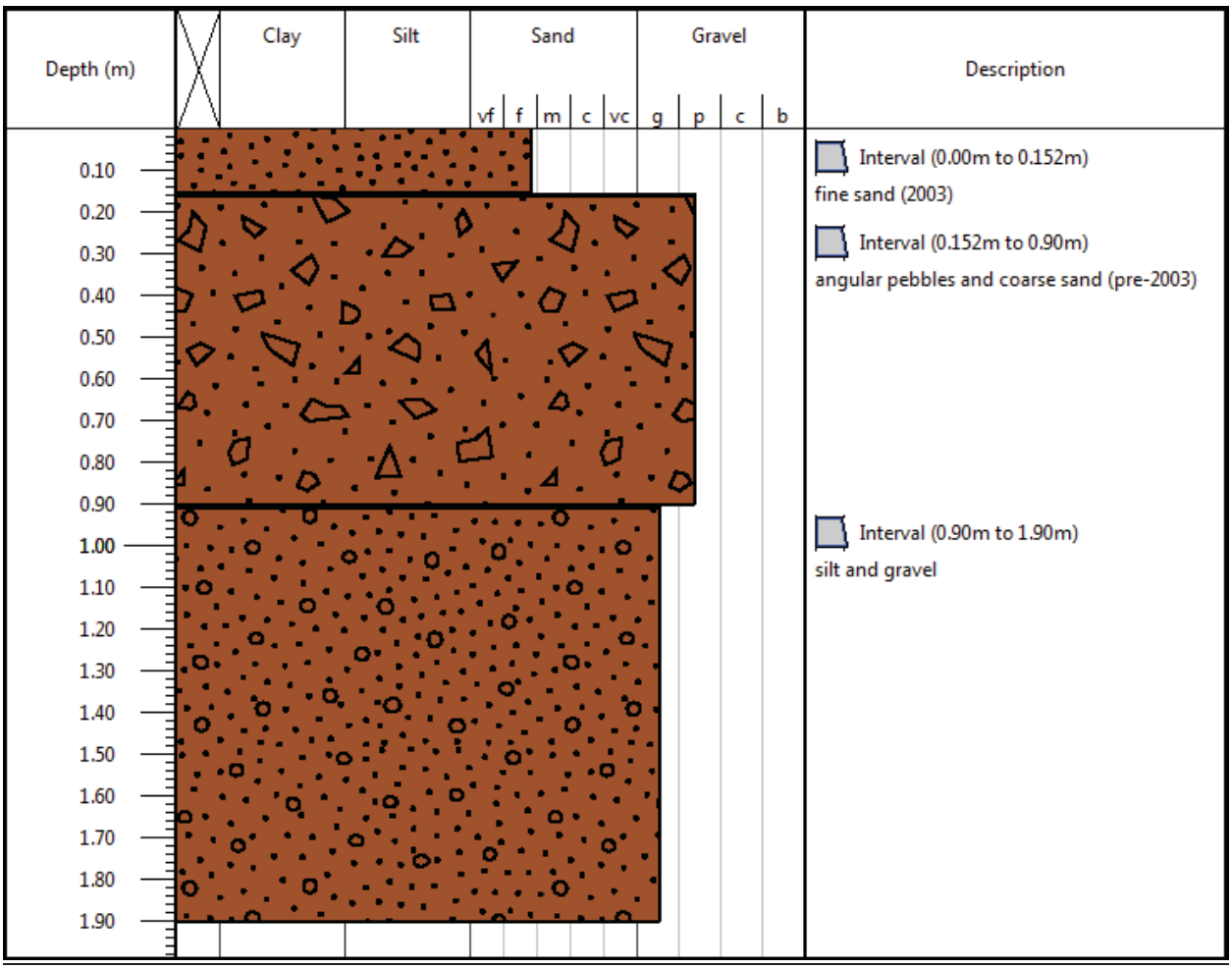


Figure 58: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
28

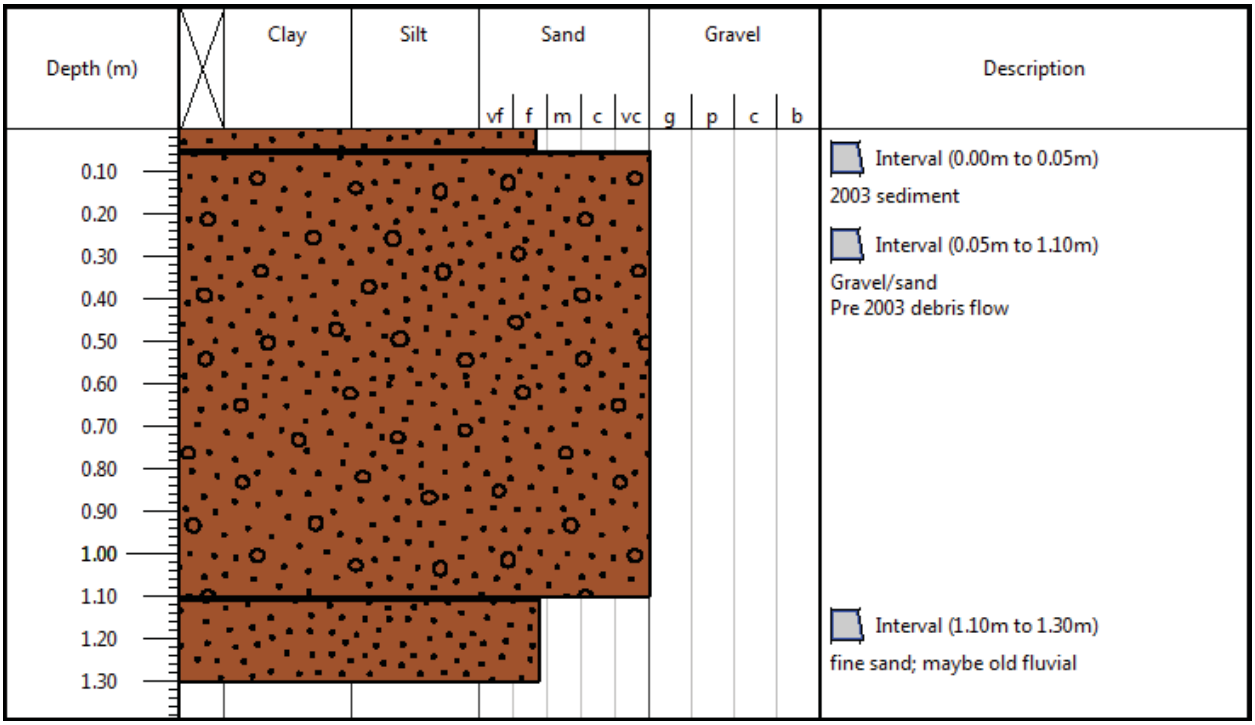


Figure 59: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit 29

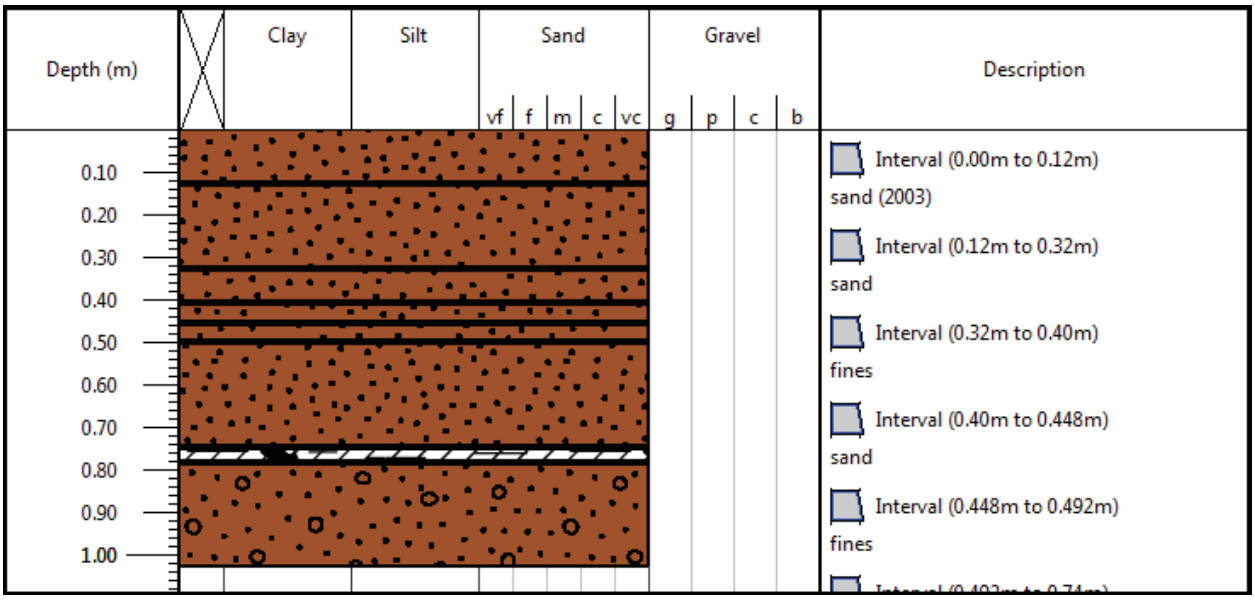


Figure 60: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
30

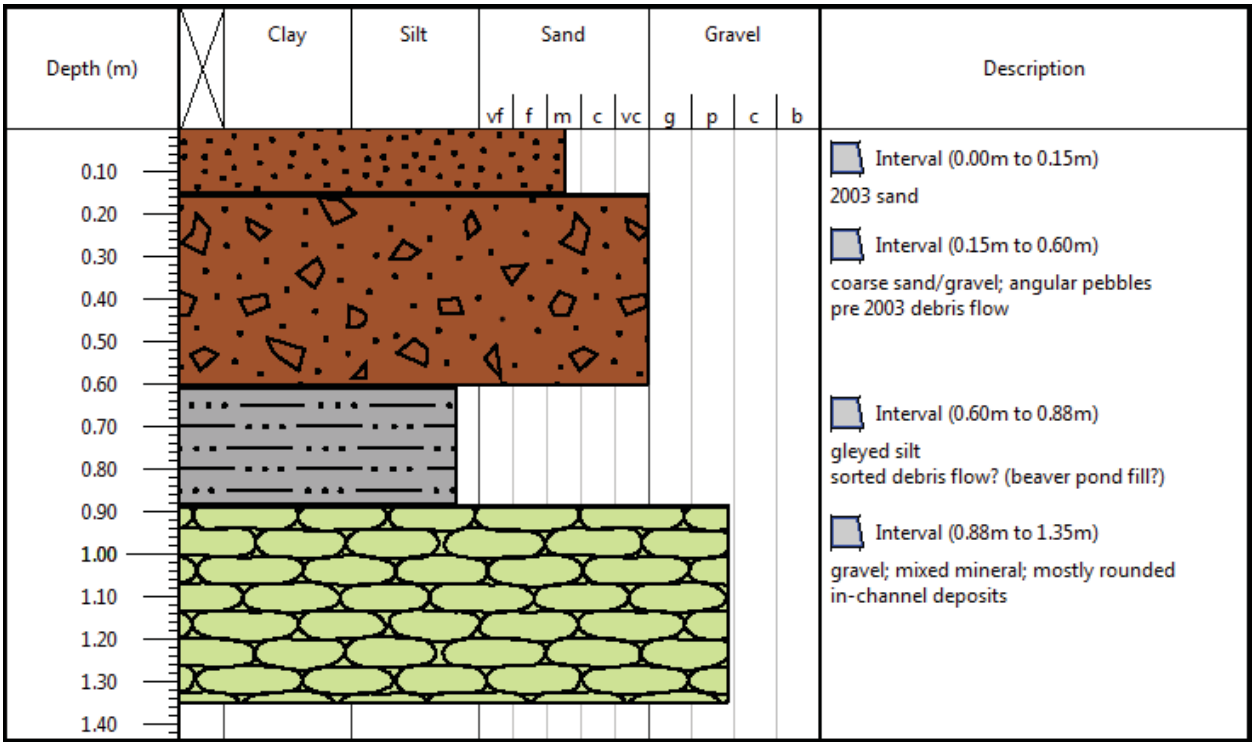


Figure 61: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit 31

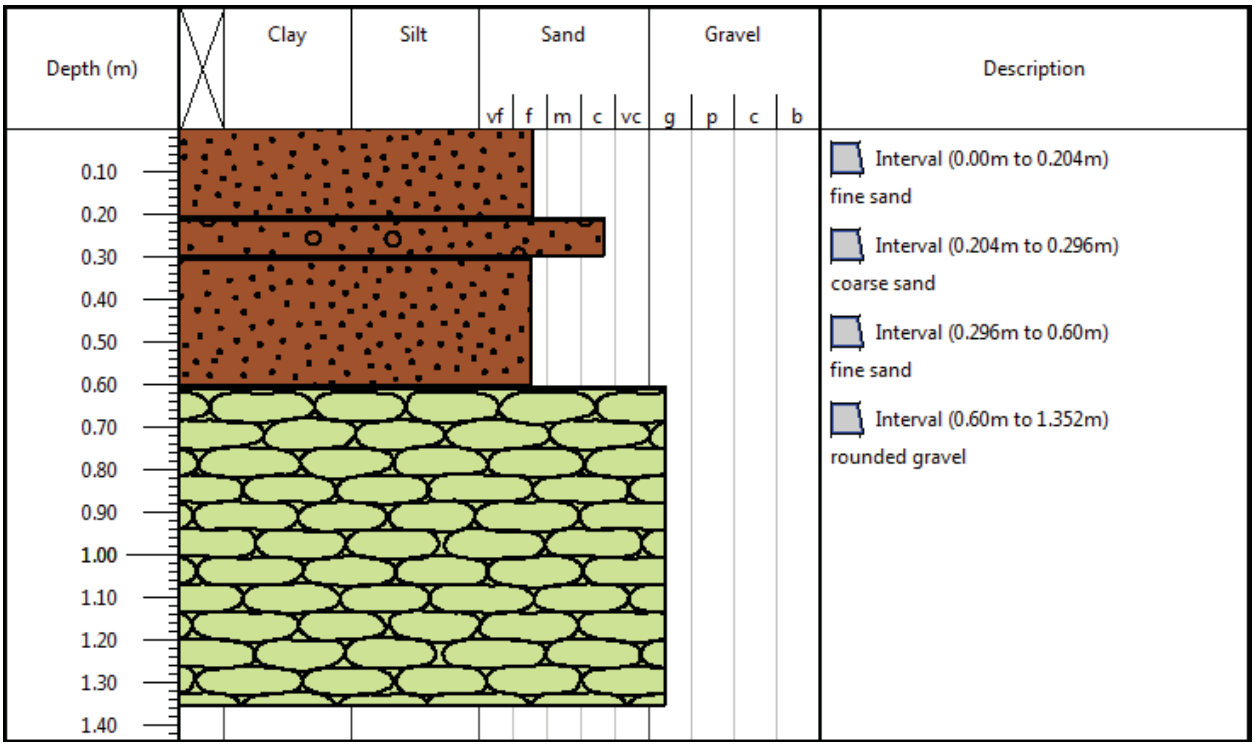


Figure 62: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
32

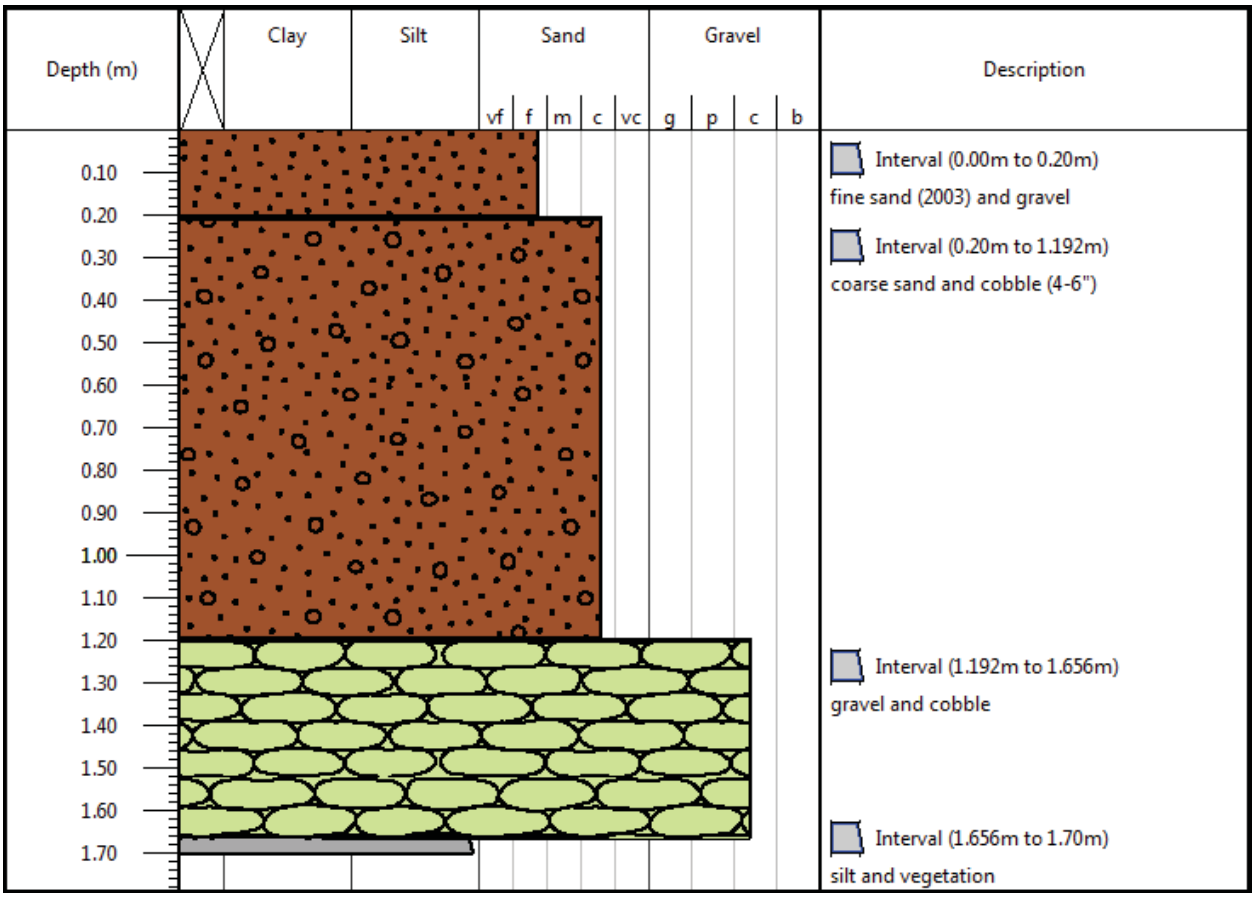


Figure 63: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit

33

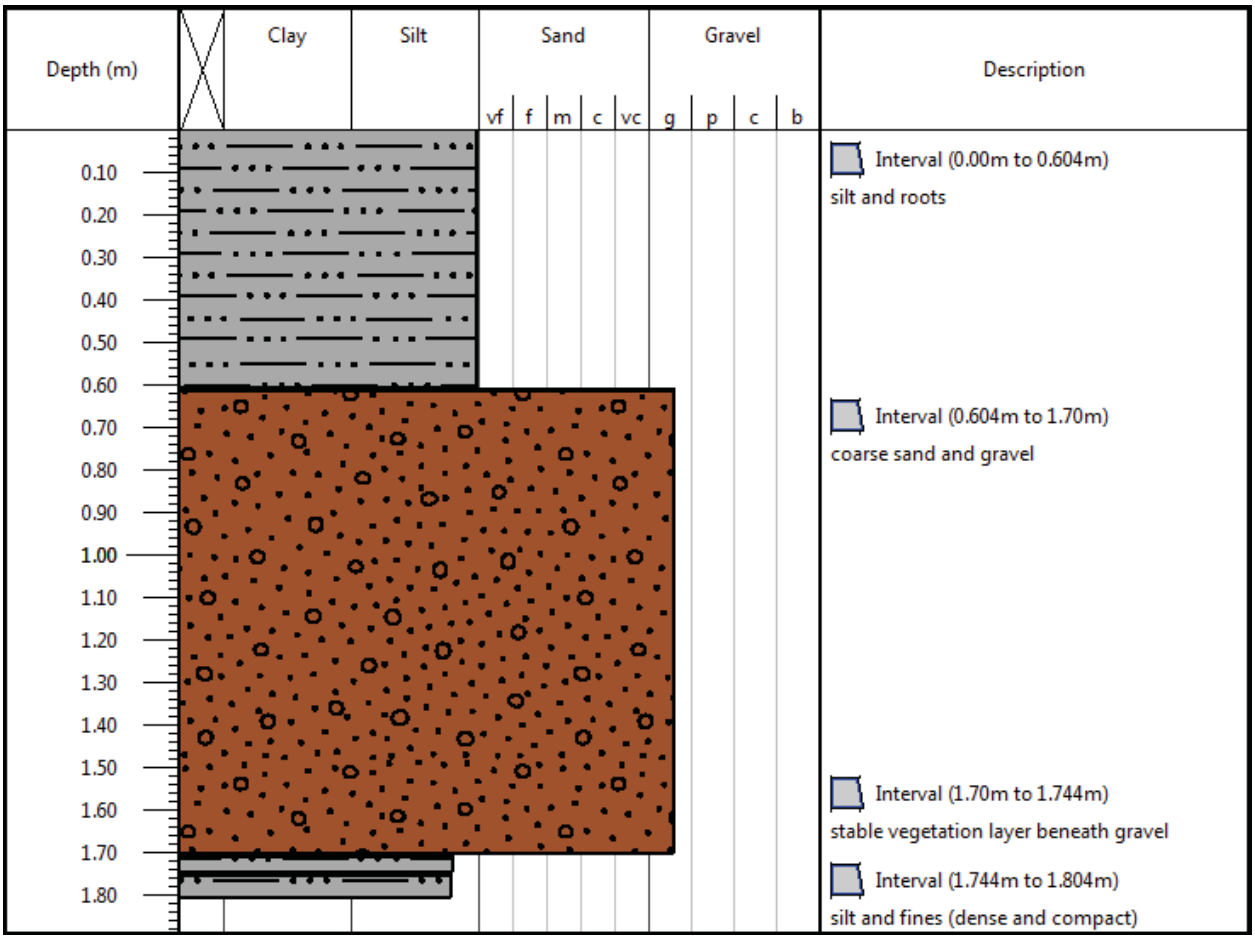


Figure 64: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
34

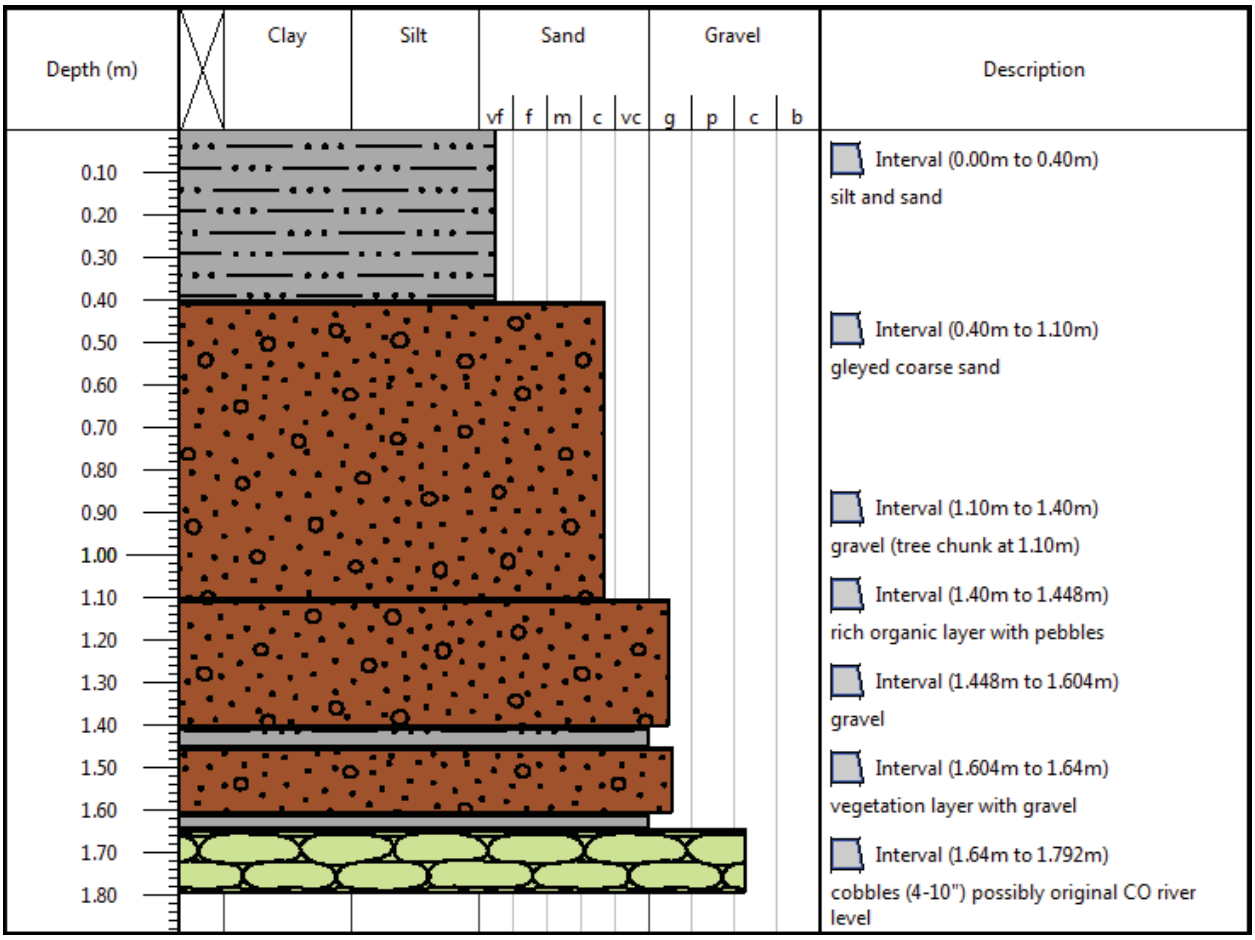


Figure 65: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit

35

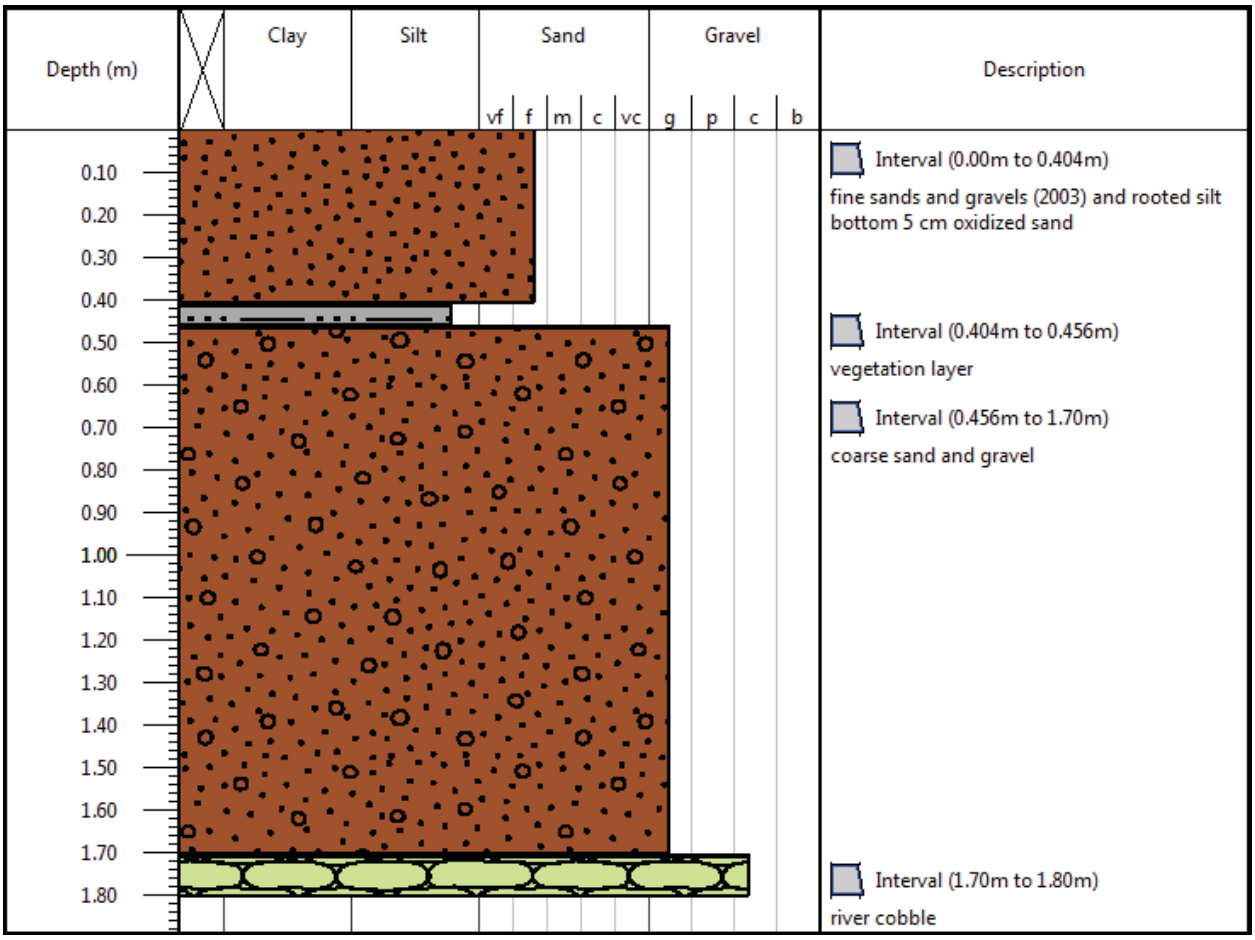


Figure 66: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
36

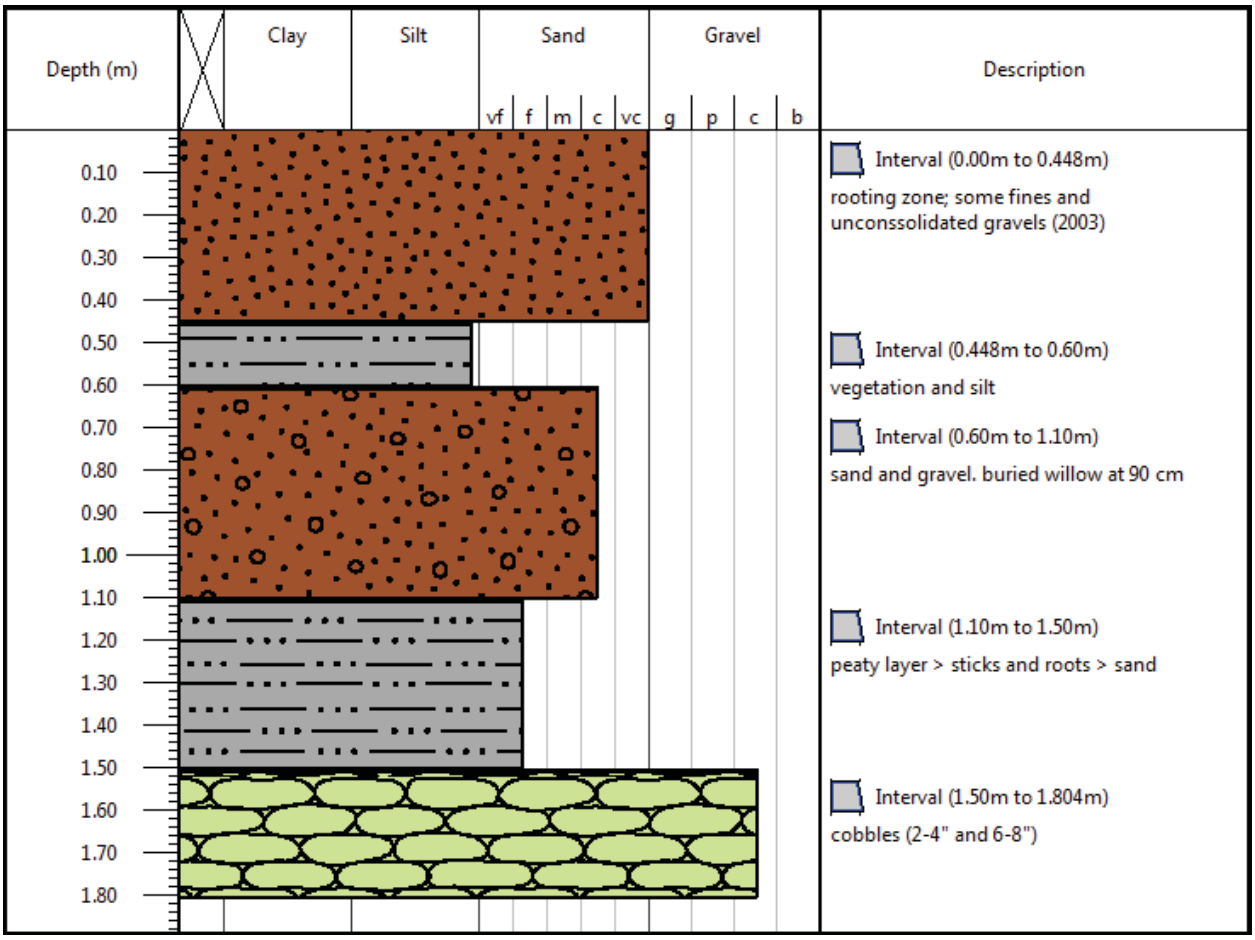


Figure 67: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
37

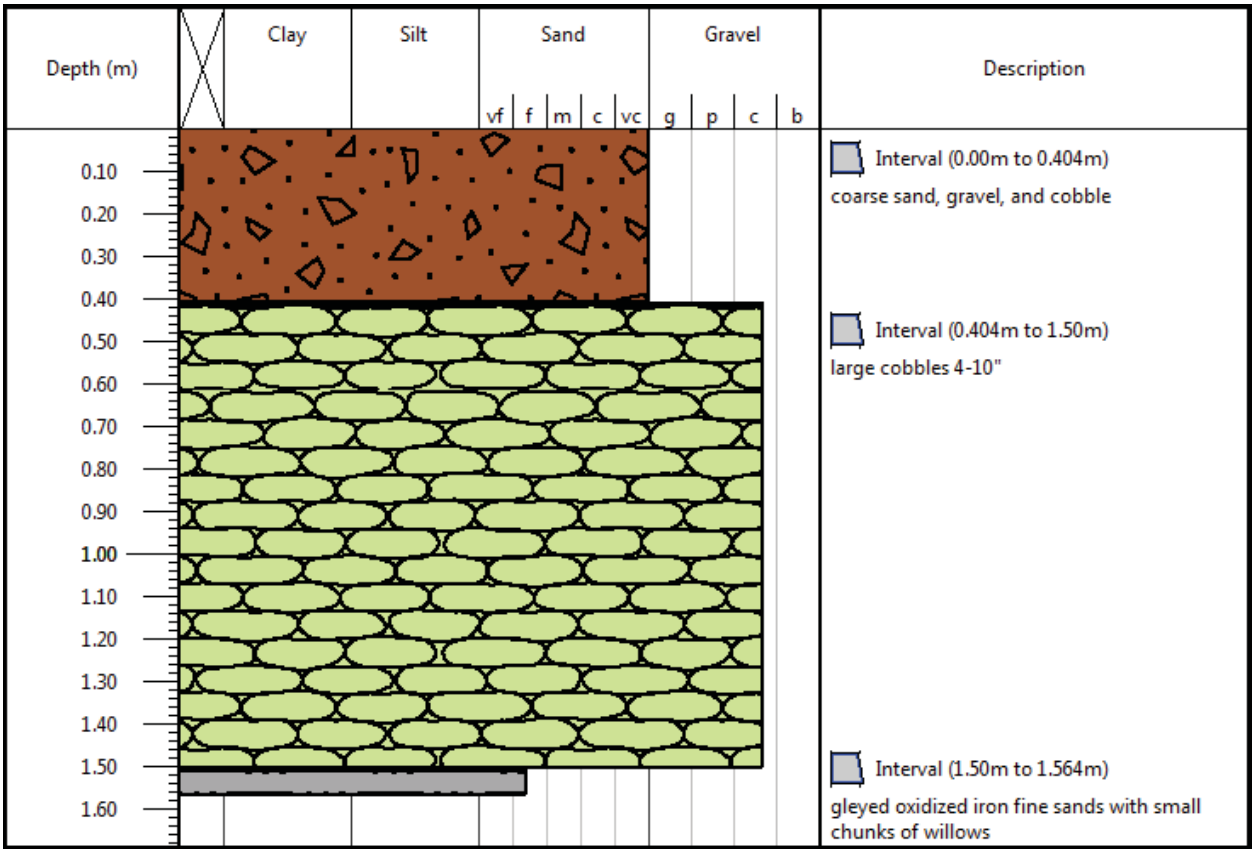


Figure 68: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit

38

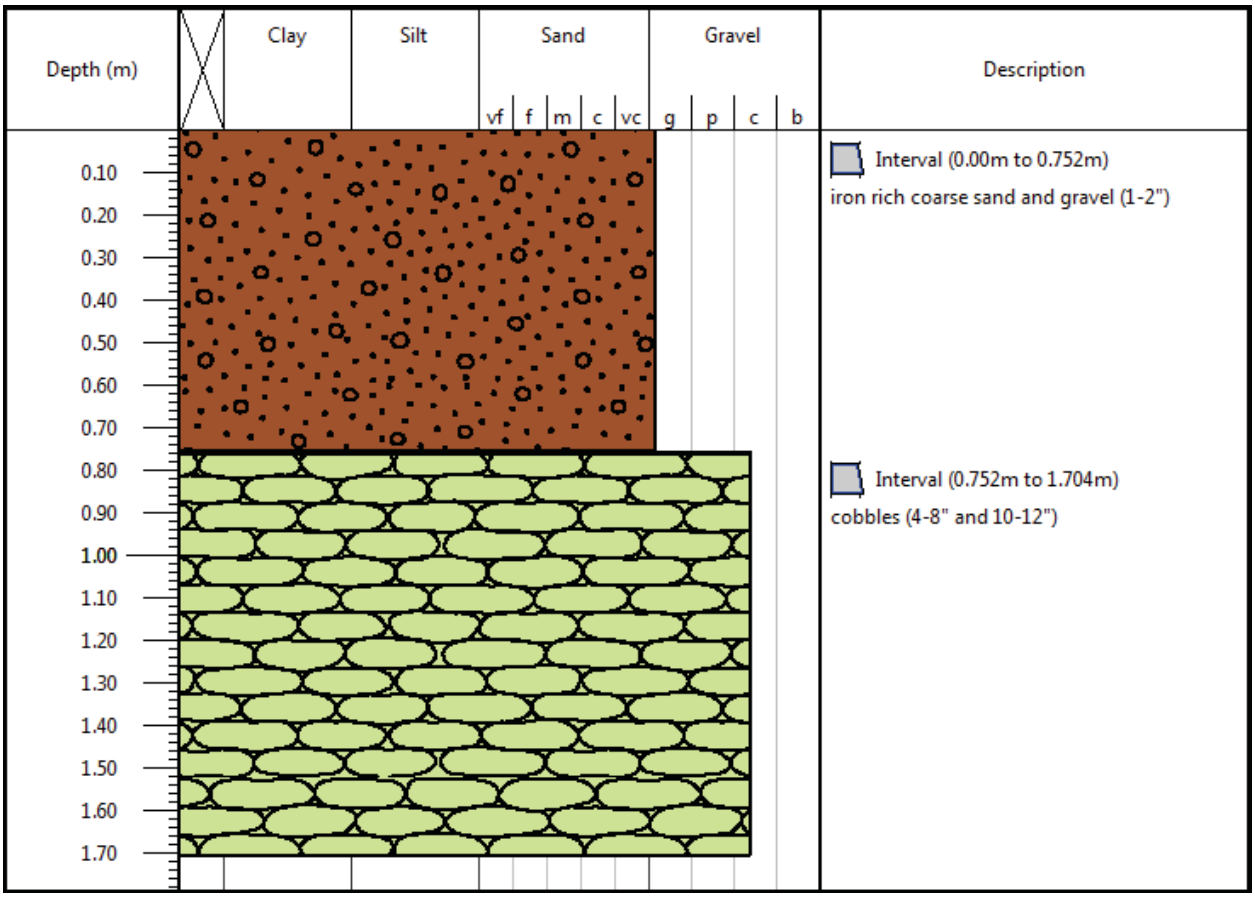


Figure 69: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit

39

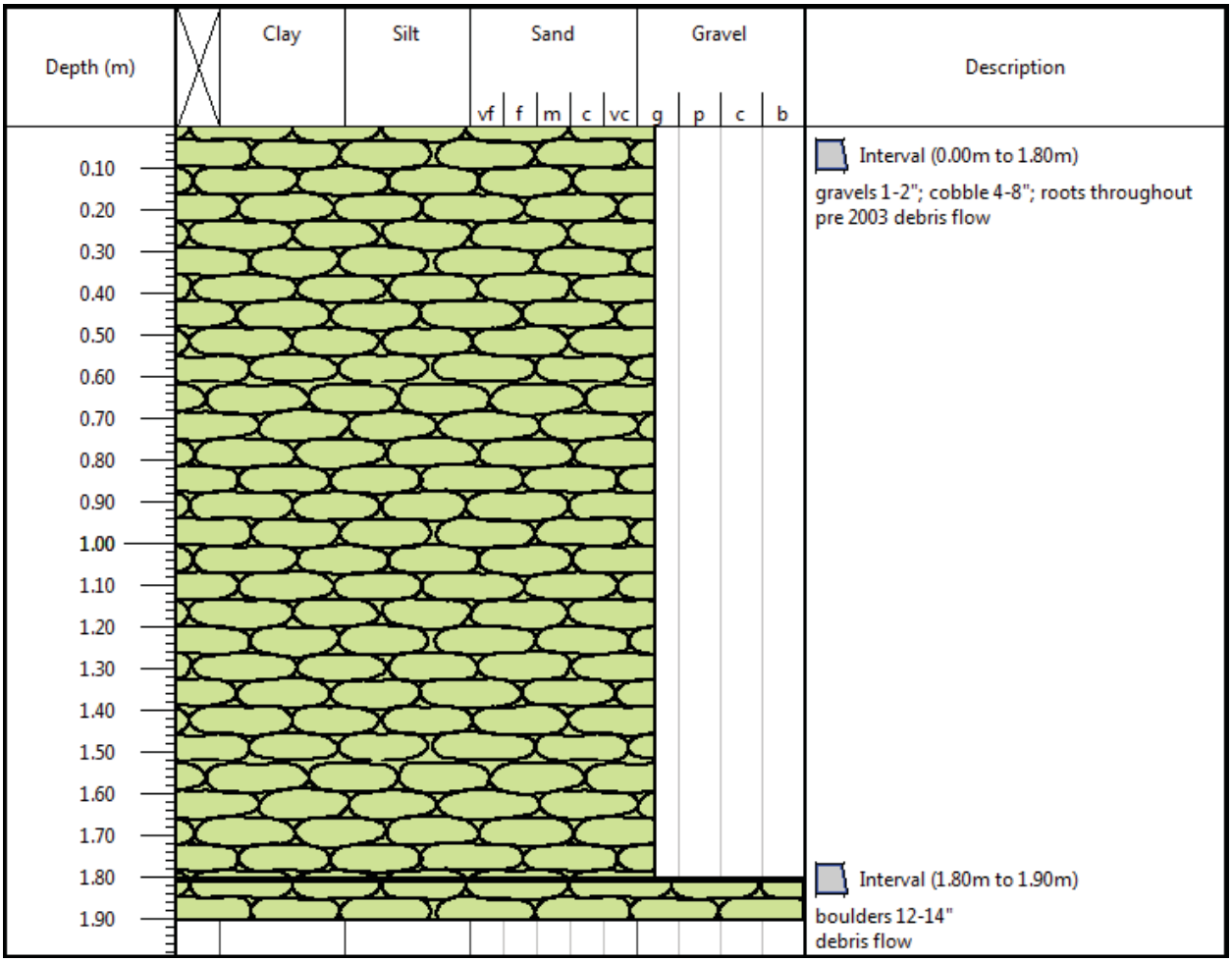


Figure 70: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
40

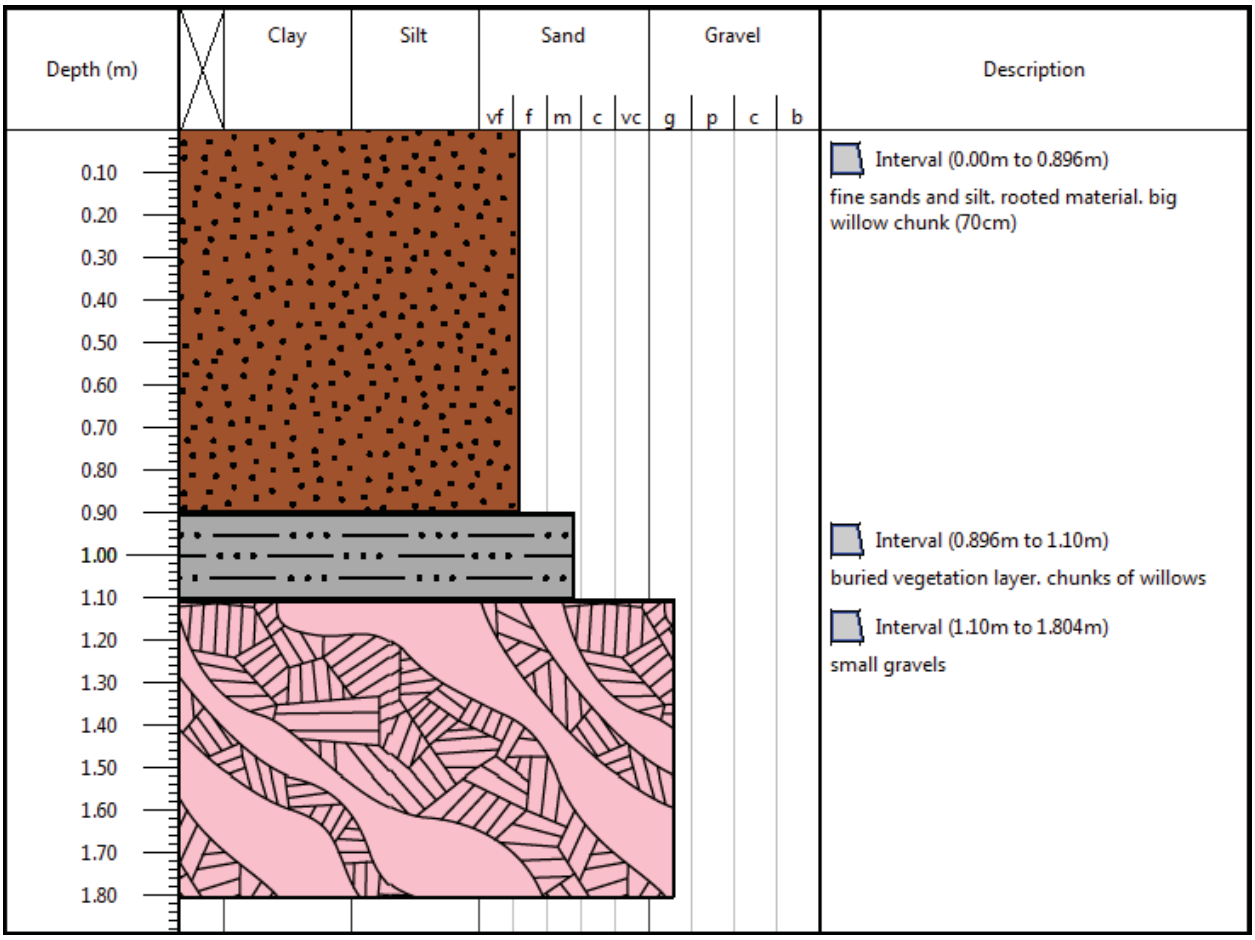


Figure 71: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit 41

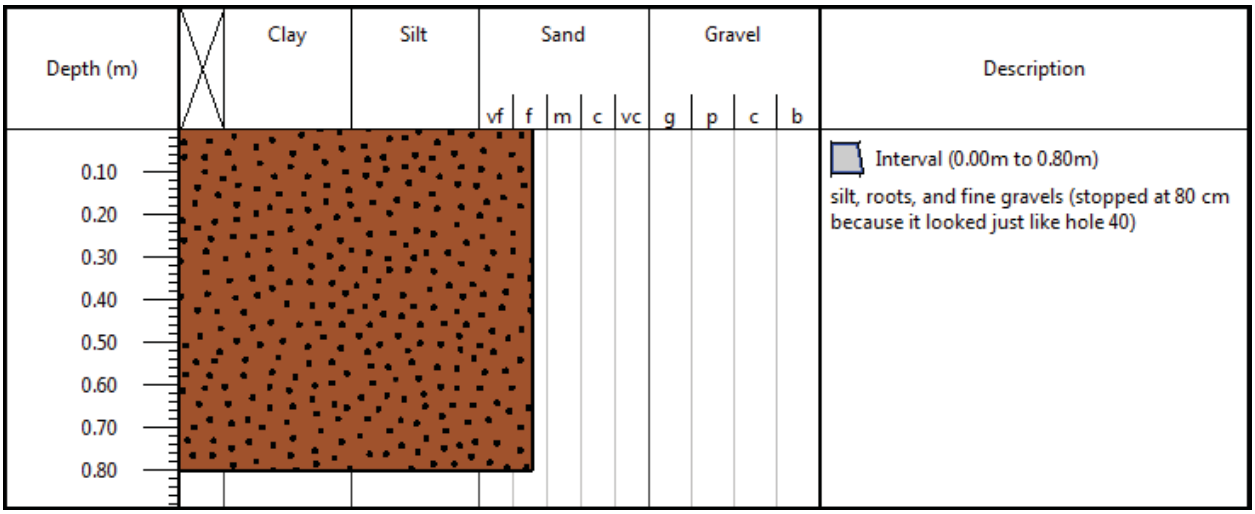


Figure 72: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
42

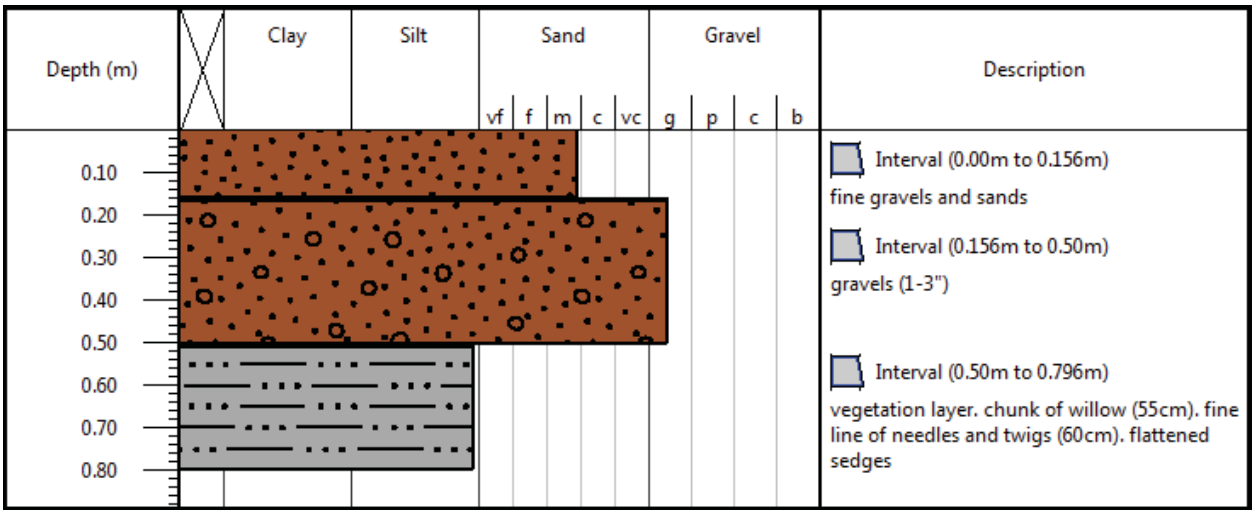


Figure 73: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit 43

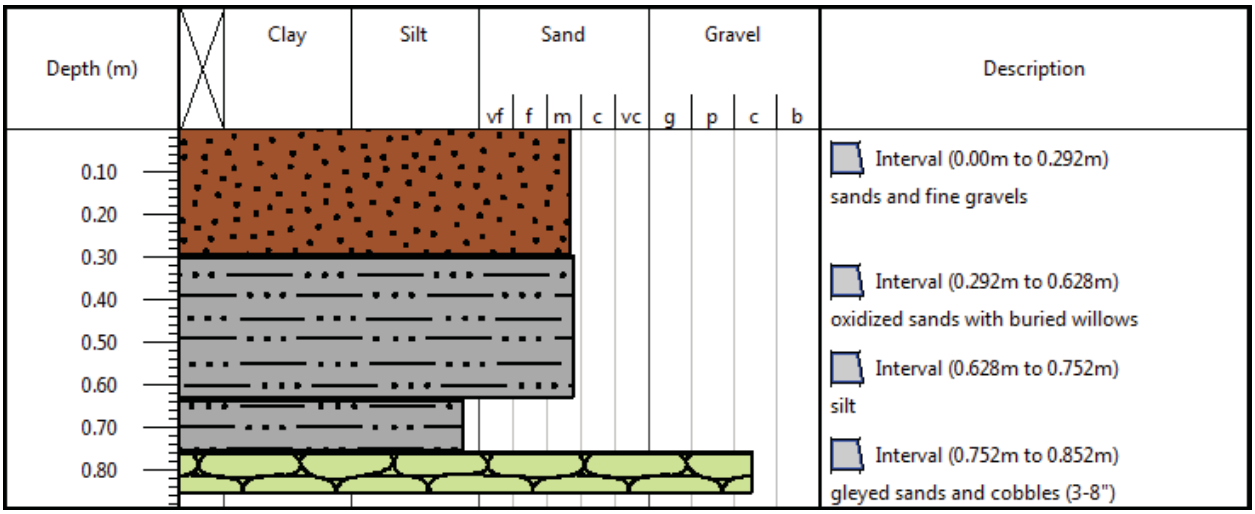


Figure 74: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
44

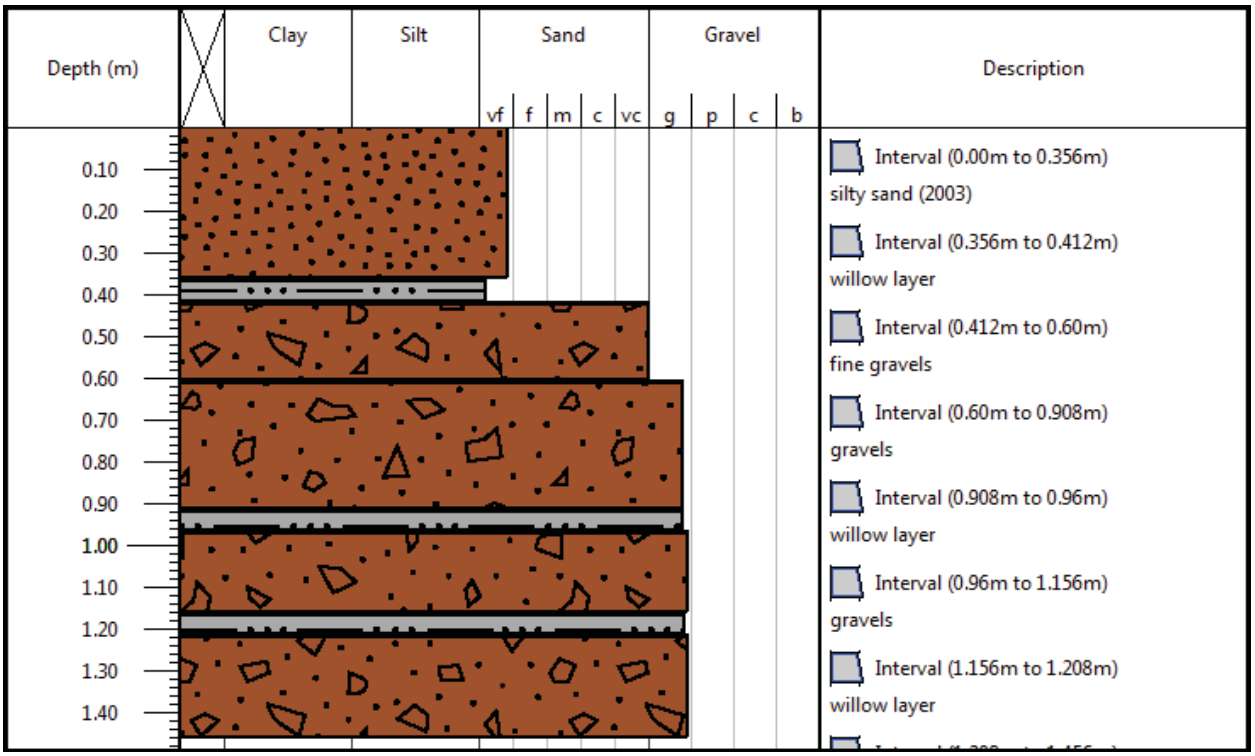


Figure 75: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
45

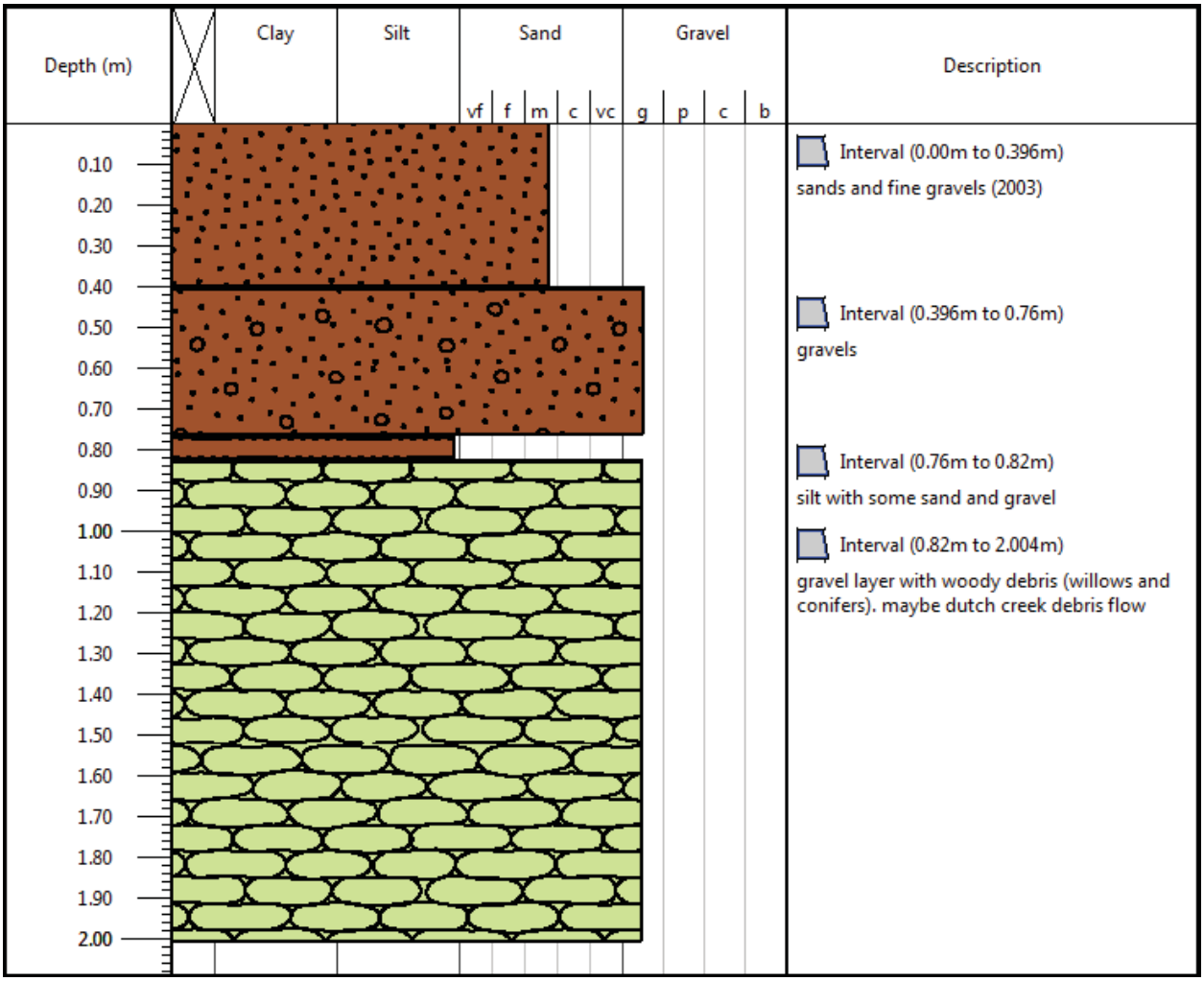


Figure 76: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
46

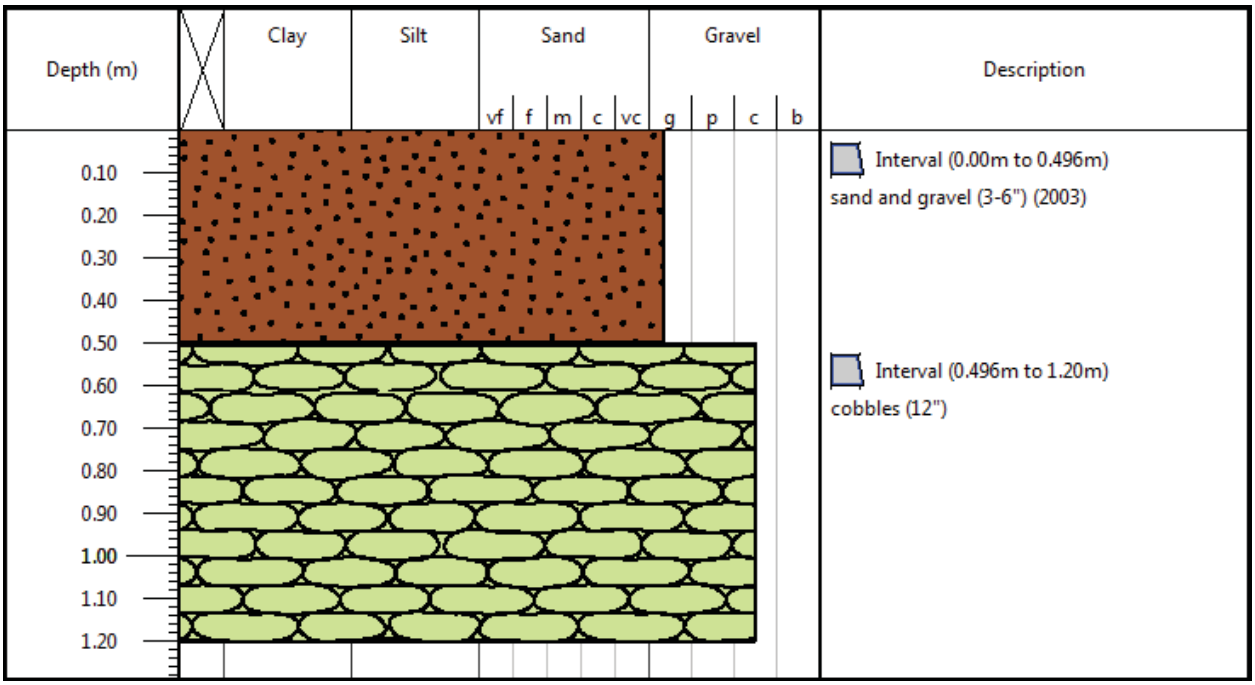


Figure 77: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
47

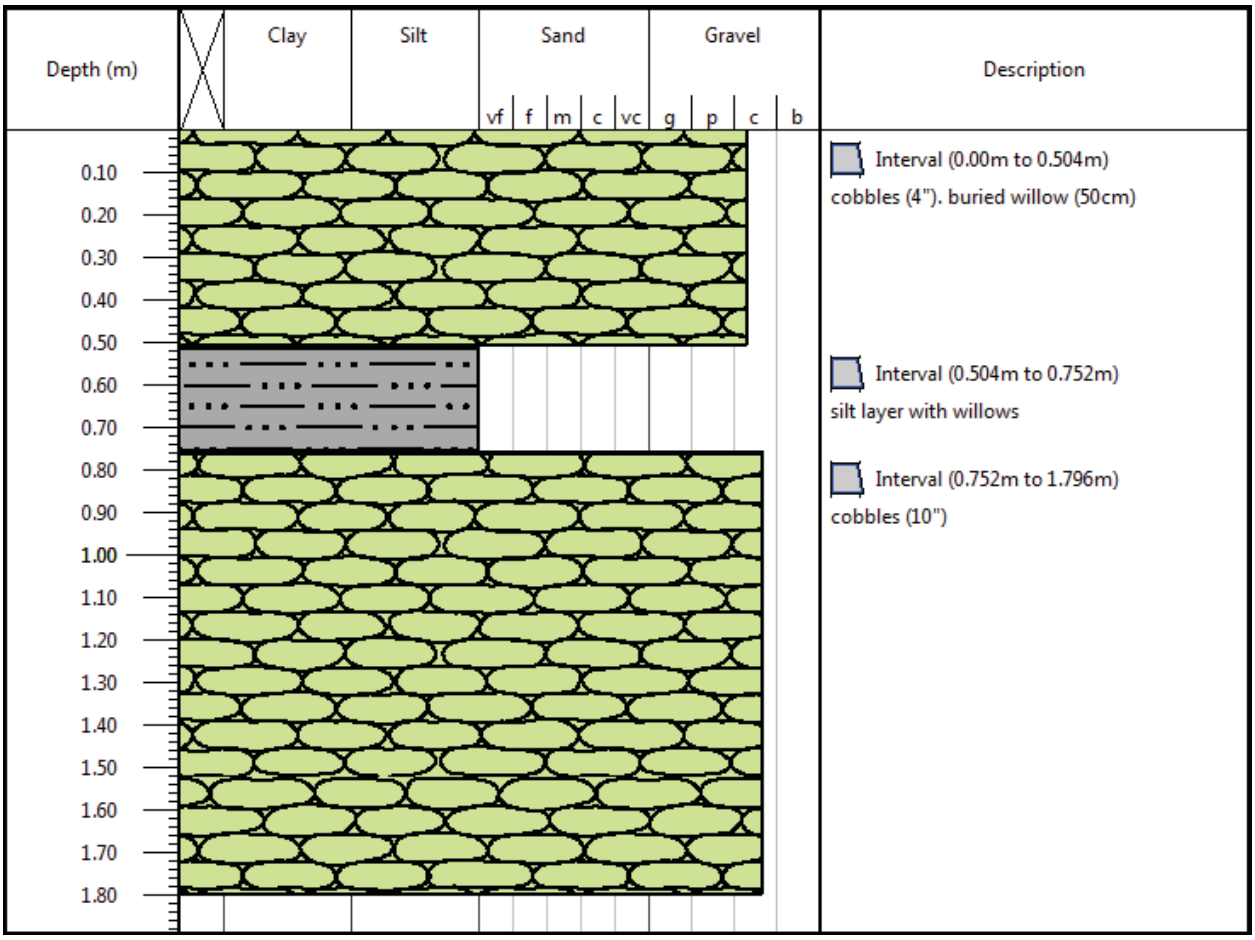


Figure 78: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit 48

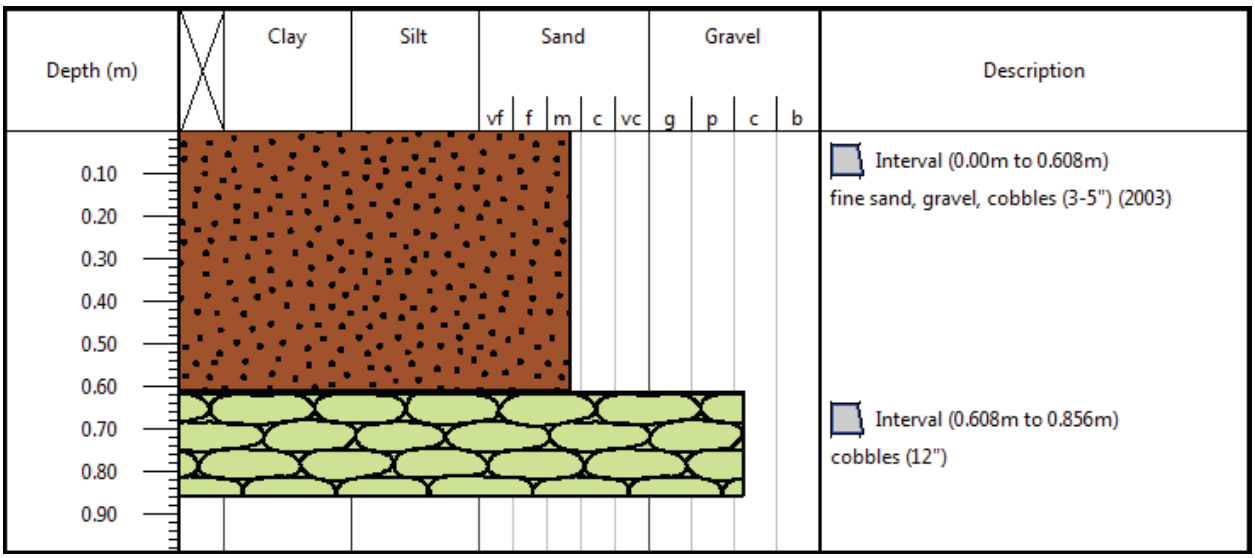


Figure 79: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit 49

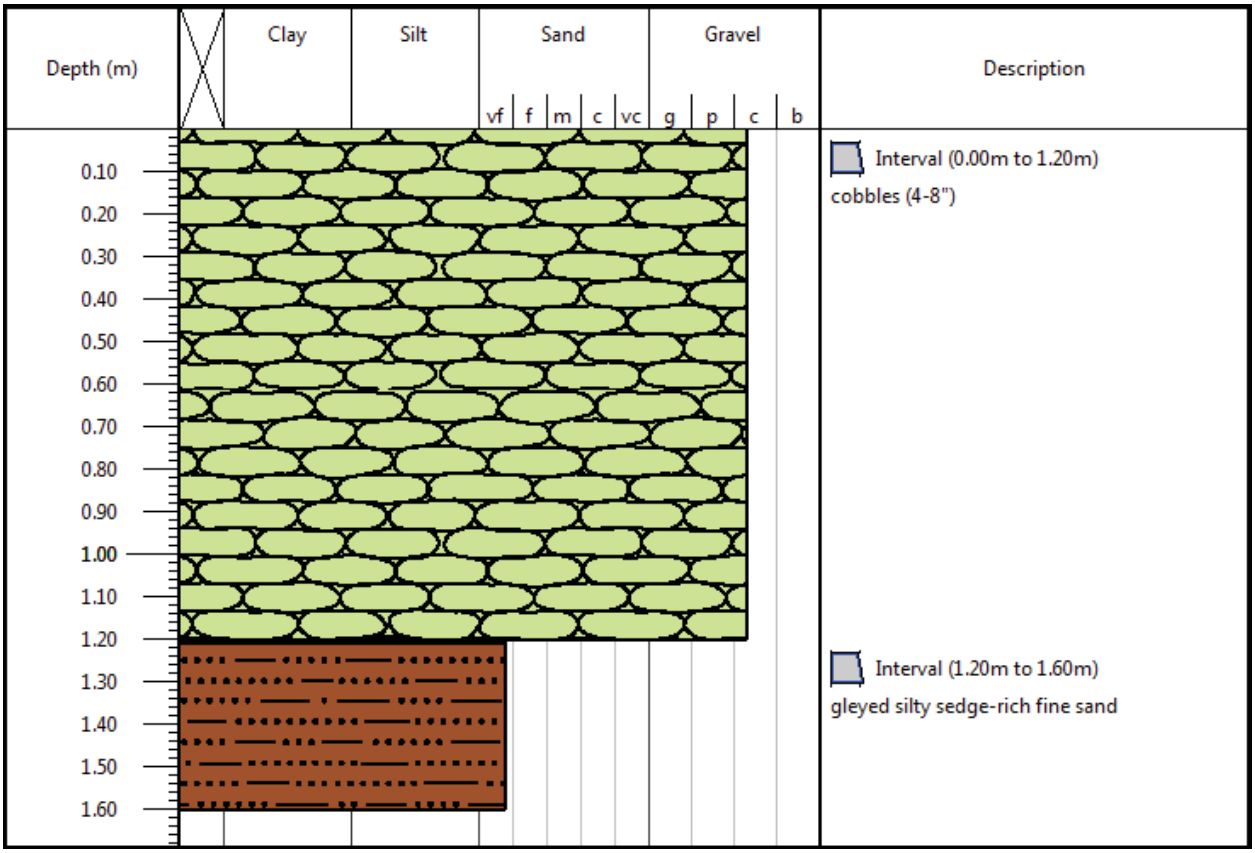


Figure 80: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit
50

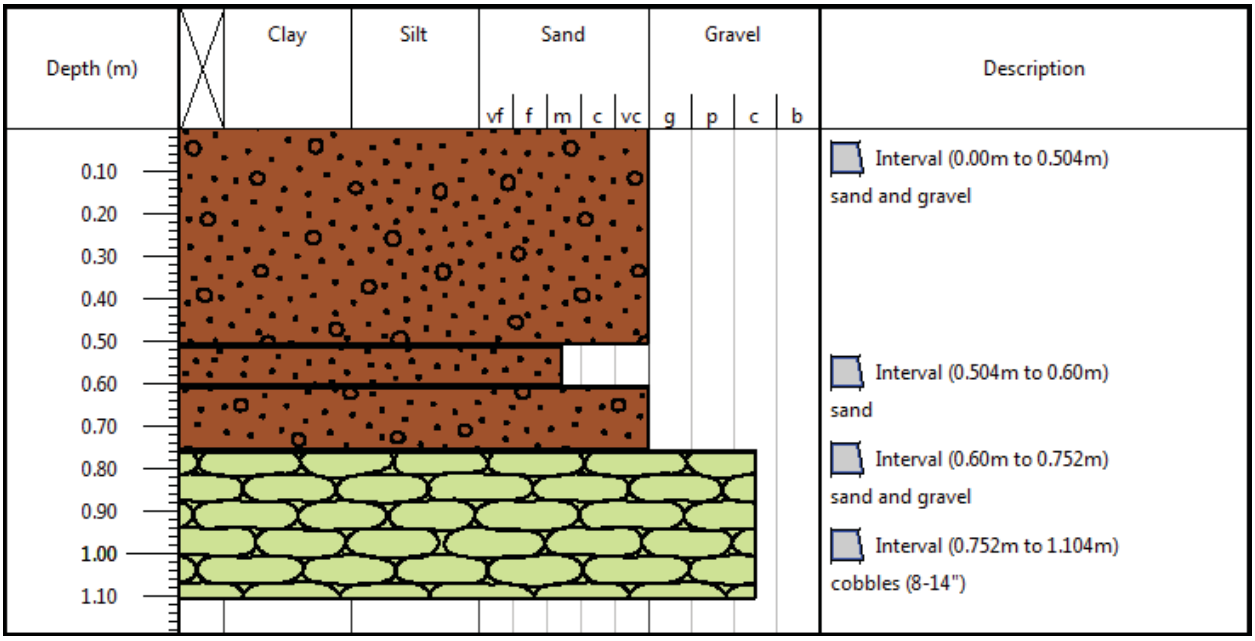


Figure 81: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

Pit 51

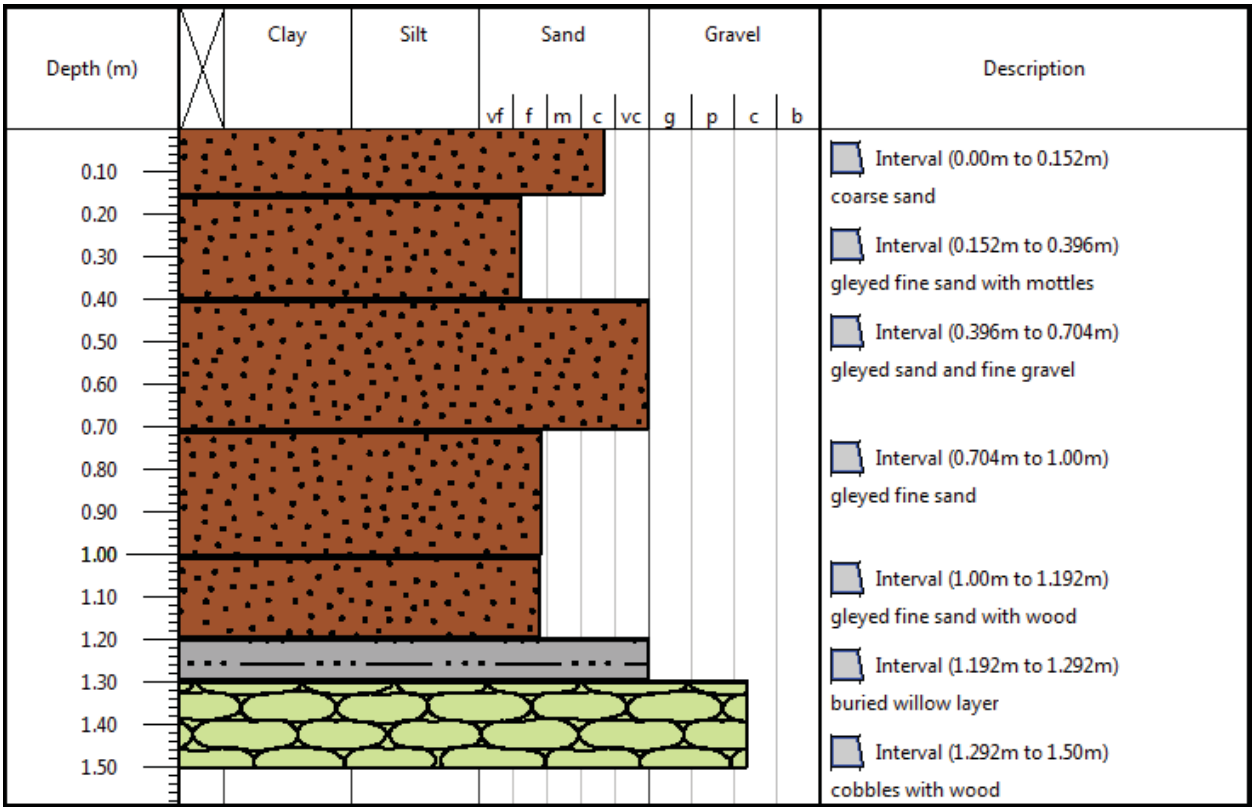


Figure 82: Stratigraphic sediment profile cross section. Representing thickness and texture of sediments and buried materials. Collected September 2009 using a Bobcat Excavator in Lulu City Wetland.

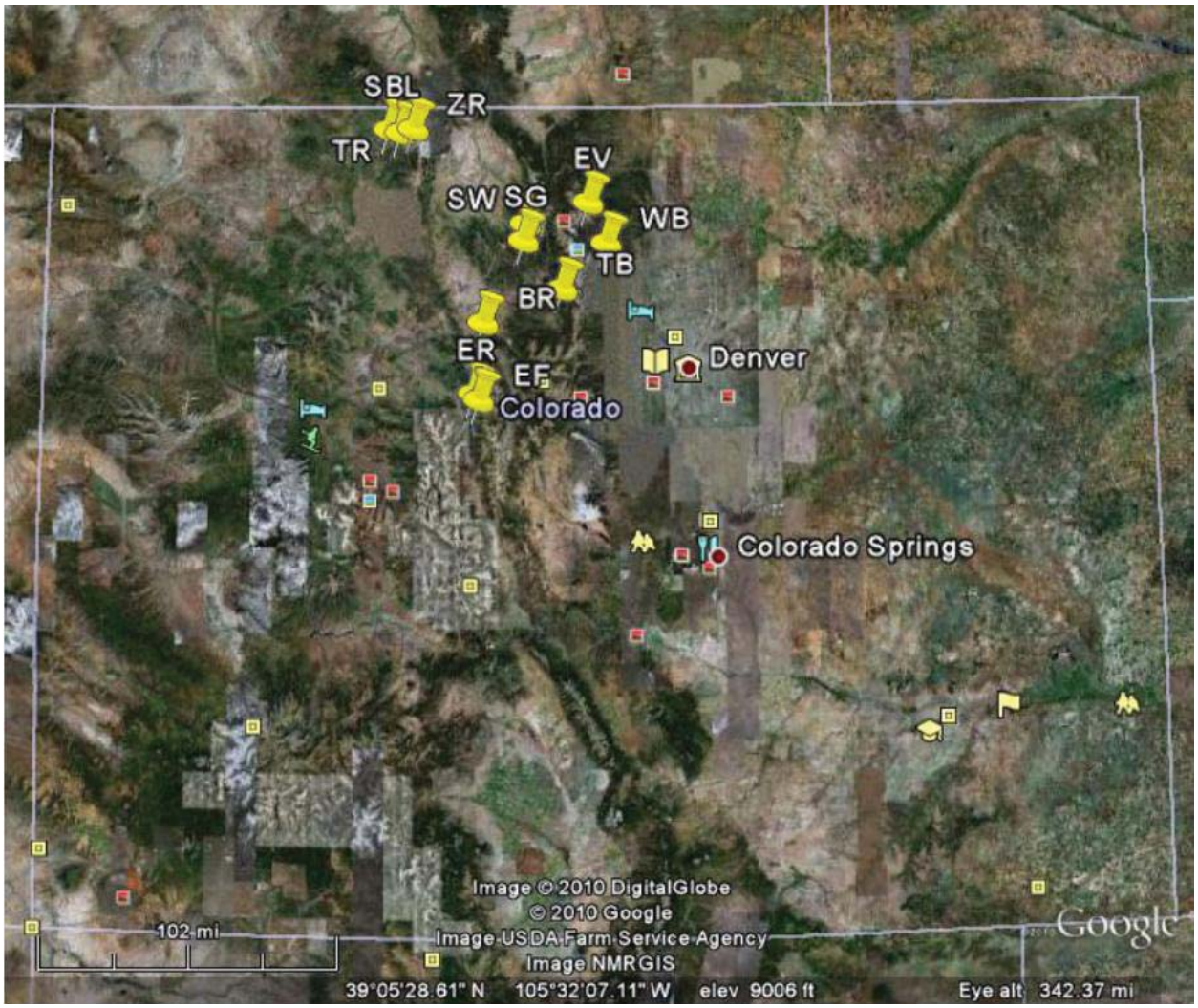


Figure 83: Location map of offsite reference sites. SBL = Willow Creek. TR = Tributary to Elk River. ZR = Elk River. EV = Fall River. WB = North Saint Vrain Creek. TB = Ranch Creek. SW = Willow Creek. SG = Willow Creek. BR = Cataract Creek ER = Homestake Creek. EF = Eagle River.

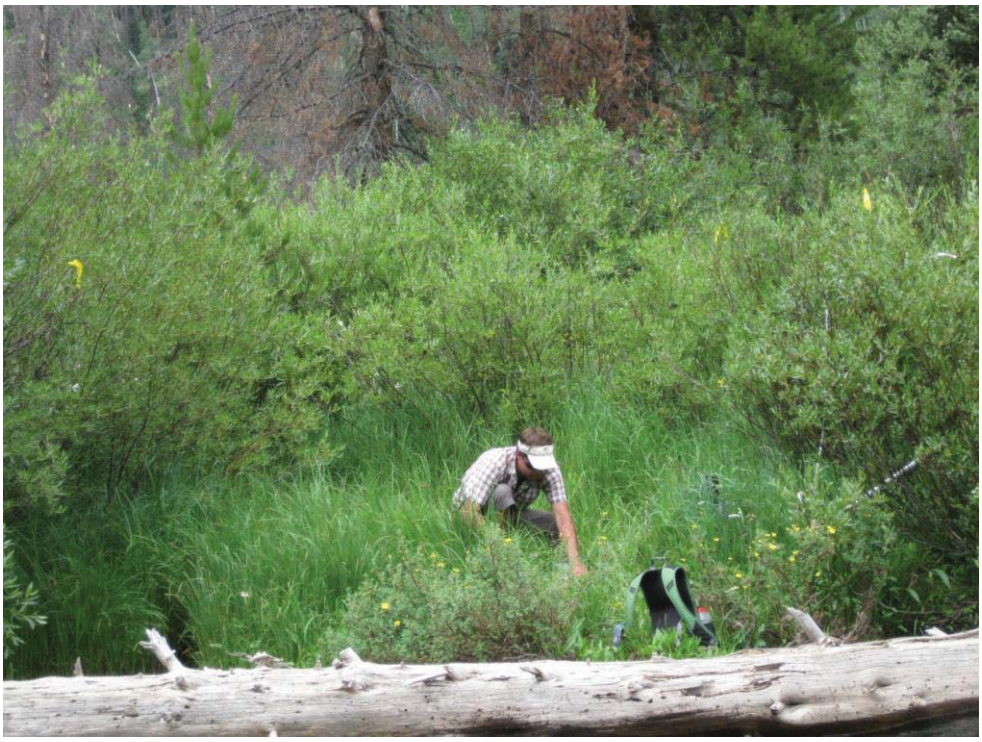


Figure 84: Offsite reference site survey of Soil texture, DTW, and riparian vegetation community structure. Note the variability of community type at each of these plots due to gradient, stream size, and other environmental factors.

Figure 85: Offsite reference site survey of Soil texture, DTW, and riparian vegetation community structure. Note the variability of community type at each of these plots due to gradient, stream size, and other environmental factors.

Figure 86: Offsite reference site survey of Soil texture, DTW, and riparian vegetation community structure. Note the variability of community type at each of these plots due to gradient, stream size, and other environmental factors.

Species	Avg DTW (cm)	Soil Texture
Salix lasiandra	58	Sandy clay loam
Carex aquatilus	44	Clay loam
Salix geyeriana	64	Sandy clay loam
Calamagrostis canadensis	57	Sandy clay loam and Clay loam
Frageria virginiana	62	Sandy clay loam
Equisetum arvense	28	Clay loam
Erigeron peregrinus	47	Sandy Loam
Pentaphylloides florabunda	36	Sandy clay loam
Heracleum sphondylium	65	Clay loam
Galium coloradoense	39	Clay
Salix ligulifolia	30	Sandy clay loam

Table 2: The 11 most common species observed at the offsite reference sites. Includes average DTW and soil texture requirements for each species.