Chadek Property Community Garden Soil Investigation

Soil Genesis and Geomorphology
Class Project, Fall, 2014

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Contents:

I. Introduction:

This project evaluated soils at the Chadek property, which is a vacant city lot located in the Morningside neighborhood of Iowa City, south of City High and a few blocks west of 1st Ave. (Fig. 1) The Chadek property is located in an older neighborhood on the northeast corner of 5th Ave. & Friendship St.

Figure 1. Location of the Chadek property in relation to City High at the top of the right image. The inset image shows the current layout of the property with Friendship St. to the south and 5th Ave. to the west. Aerial photos (2013) from Johnson County Property Viewer[1].

The City of Iowa City intends to develop a portion of the site for use as a community garden, which will provide multiple benefits to the community. Iowa City has already set up a community garden plot in Wetherby Park that has been a productive facet of the park's surrounding community. Community gardens improve many aspects of an area by stimulating community development, social interaction, and encouraging independence. Besides the numerous social economic benefits, community gardens also provide access to fresh produce and plants, making it easier for residents to incorporate fresh fruits and vegetables into their daily diets. The fresh produce also gives community members self-satisfaction in growing their own vegetables, while also allowing them to control what is applied during the growing process.

The Chadek property is presently an unused lot, but has the potential to become a productive and attractive piece of green space. By converting part of this parcel into a community garden, we have an opportunity to not only conserve a potential beneficial piece of land, but build a stronger community within our city. The property has a long history of private use. We investigated historical sources and previous investigations to evaluate how these past uses may have impacted properties of the site's soil that could influence their suitability as garden soils.

Site history was obtained using Sanborn maps[2], which provide property maps for the site dating back to 1895, along with other online references and historical maps. The site was purchased in 1895 by W.F. Main, who quickly developed a large, four story, L-shaped factory on the land (Fig. 2). Sanborn maps show the building was located on the northwest section of the lot with a coal burning furnace and engine room located on the north side of the building, along with two sets of railroad tracks leading up to the northeast side of the building. The Rock Island/Pacific Railroad ran along the north boundary of the lot. The factory was originally called Puritan Manufacturing which manufactured costume jewelry. The factory was later owned by the Franklin Price Company which manufactured wooden and concrete posts/pillars. The Boemer-Fry Extract Company and the National Hybrid Seed Corn Company were also located at this factory at one time. In 1937, the factory burned down and was demolished leaving only the railroad tracks. In 1952 the property was purchased by Carl Chadek who used the adjacent property for his trucking business and the Chadek property for the storage of gravel and dirt. The property was also used as a play area for the neighborhood children. The property has been vacant since the City of Iowa City purchased it in 2008 (Fig. 3).

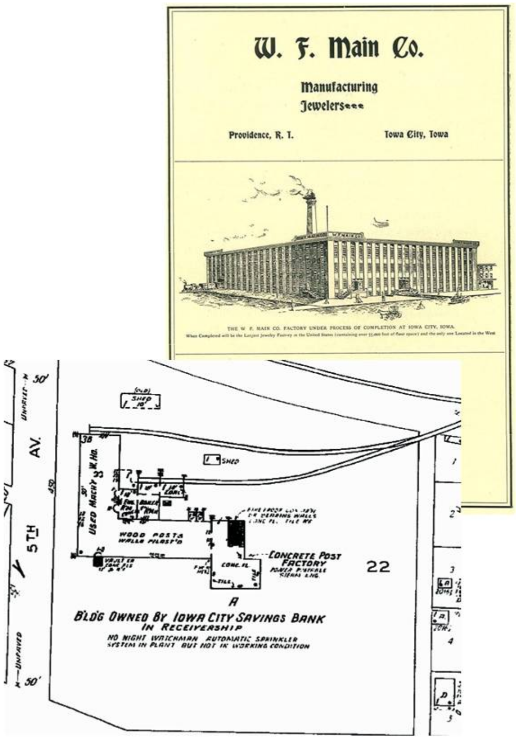

Figure 2. Image of Sanborn map showing the design and layout of the Chadek property in its earlier years.

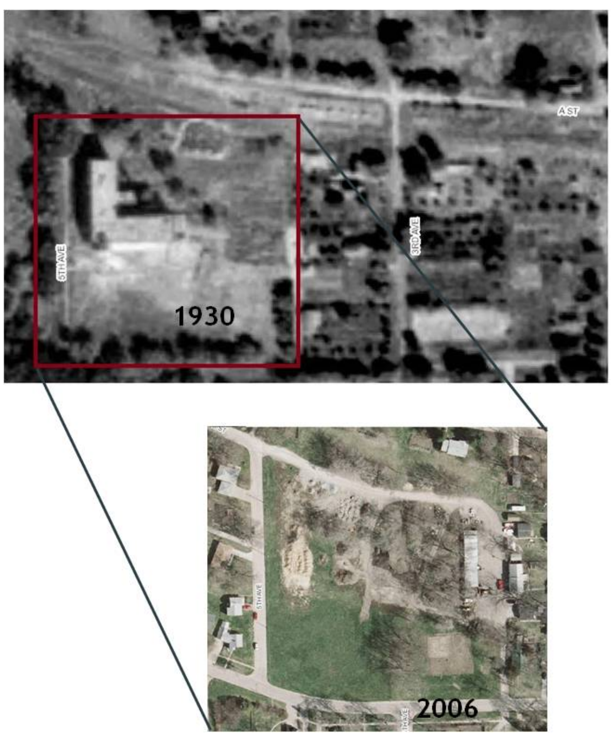

Figure 3. Historical air photos showing the property in 1930, shortly before the main building burned down, and more recently in 2006. Images from Johnson County Property Viewer.

In order to get an overview of what types of soils *should* be present on the property, we used Web Soil Survey[3]. The Web Soil Survey is an online database with soil maps and information for the entire United States. Web Soil Survey indicates that the Downs silt loam soil series is the dominant soil mapping unit at the Chadek property while the Tama silt loam soil series occurs in the southeast corner of the property (Fig. 4).

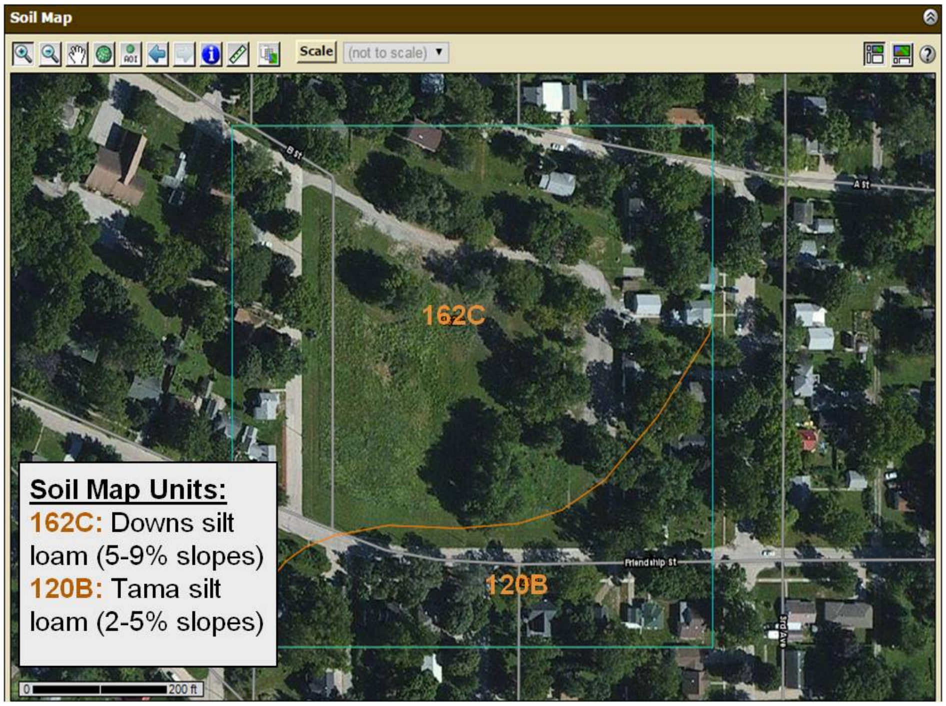

Figure 4. Screenshot from Web Soil Survey shows the official U.S. Department of Agriculture Soil Survey soil mapping units at the Chadek property. Most of the property is mapped Downs silt loam.

Both of these soil types are formed in loess (windblown silt), which is known for being very fertile. Both soils are formed on gentle slopes, are well drained, have high water storage capacities, and the depth to the water table and/or any restrictive features is greater than 2.5 meters. In other words, if unaltered, the property would be considered to be prime farmland of statewide importance. However, as one could imagine, judging from the site's history, and as we later show, the site's soils have undergone many alterations. The purpose of our investigation was to verify the properties of the soil actually present on the Chadek property, and make recommendations for a community garden accordingly.

II. Methods:

In order to assess the Chadek property, various field and lab methods were used to garner information about the property's soils. The field methods used included things such as visually assessing the terrain and comparing it to historical maps, taking soil core samples and bulk density samples, and excavating and describing soil profiles. The lab methods used included measurements and tests for bulk density, electrical conductivity, pH, humus, potassium, nitrate, and magnesium. There was also a limited site investigation done at the site by an outside source under contract with the City (Terracon)[4].

The property was divided into 4 quadrants and each quadrant was assigned to a group of students (Fig. 5). Each group assessed their quadrant, taking core samples with a coring tool, and digging holes to get a better look at the subsurface to identify and describe the soils present. The cores were used to provide quick soil descriptions and characteristics to get an overview of the quadrant and sub divide accordingly. Once the sites of interest were determined, holes were excavated by hand to depths of 40-60 cm to further investigate the detail of the soil horizons and other features (charcoal, bricks, etc.; Fig. 6). Bulk density samples (collected in 3 inch tall, 3 in. diameter aluminum cylinders) and soil samples were also taken from the sites, which were further examined in the lab at a later date.

Figure 5. Shows how the property was divided into 4 quadrants.

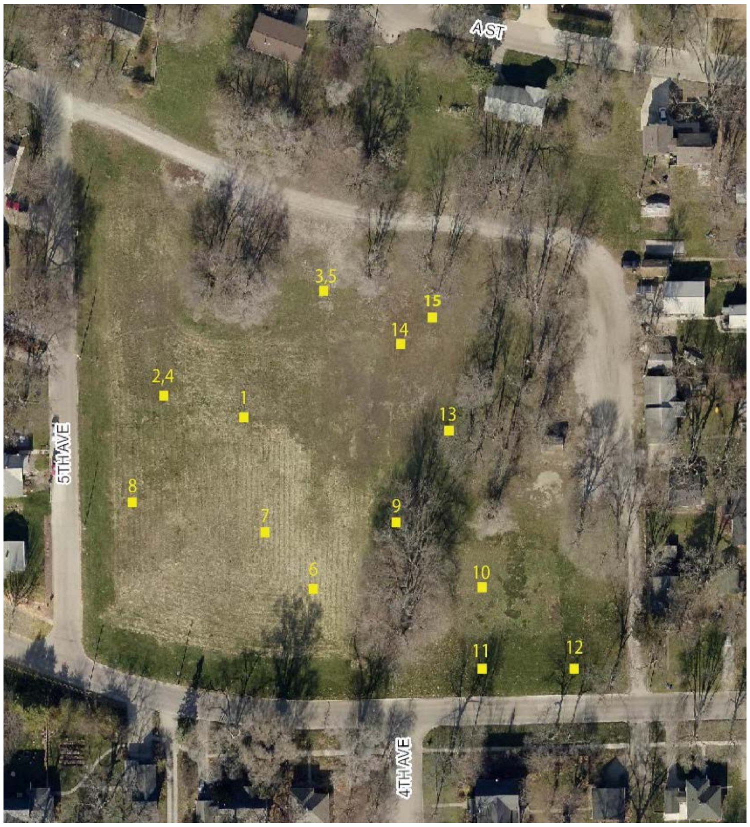

Figure 6. Location of soil descriptions and samples collected during the project.

In the lab, the bulk density samples were measured for volume, dried, and weighed in order to determine the bulk density of the soil at each site (Bulk Density = dry weight/volume). The density of the soil is important because if the soil is too dense, it becomes impenetrable to roots and plants have a hard time growing in it. The soil samples were then ground and mixed with a weak acid solution (10% sodium acetate) in order obtain an extract that could be tested to assess some chemical properties that are important in soils used for growing plants. These assessments included tests for humus, potassium, nitrate-N (Indicator Test), and magnesium. Some of the ground soil was mixed with deionized water and the supernatant liquid was tested for pH, electrical conductivity, and a nitrate strip test.

The electrical conductivity test is used to detect salt content. Excessive salt buildup will have a higher electrical conductivity rating, which would indicate restrictive conditions for plant growth[5]. For this test we took a subsample for each soil sample, mixed it with water and used an EC pocket meter to measure and record conductivity. After each EC test, we waited 10 to 15 minutes before using a pH pocket meter to measure and record pH levels. The pH test is useful because plant nutrient availability depends on pH, and most common nutrients are available in weakly acidic to neutral conditions (pH 6.7-7.2)[6-10]. Humus is the source of most plant nutrients, also aids in water holding capacity. Potassium, nitrates, and magnesium are all very important plant macronutrients, so they were tested for also. The humus, potassium, nitrate, and magnesium tests were all performed on the soil extract using their respective indicators and strips from a LaMotte™ soil test kit[11]. Results of the lab analyses are shown in the Appendix.

A limited site investigation (LSI) was conducted at the site in September, 2014 by Terracon, Inc. They took two soil borings in two different areas of interest on the site (Fig. 7), not only to take samples and tests to document lithology, color and moisture content, but more importantly, to test the soil for volatile vapors/compounds(VOCs) and Resource Conservation and Recovery Act (RCRA) metals and contaminants.

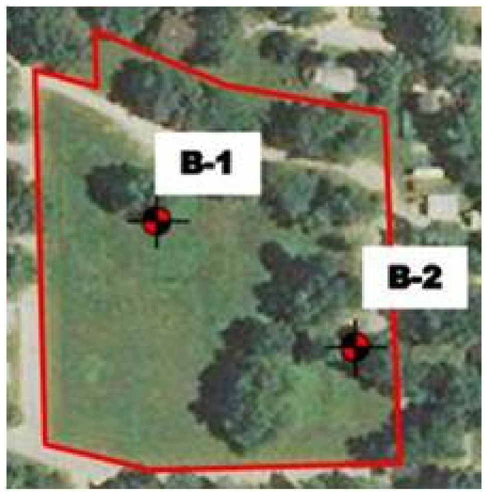

Figure 7. Image showing the location of borings where Terracon took samples during the Limited Site Investigation.

III. Results:

Through our field assessment, we were able to obtain descriptions of the soil profiles map the distribution of soils at the Chadek property. Each group performed a detailed investigation of their quadrant and recorded the following results:

Quadrant 1, located in northwest section of the property featured soil that was heavily compacted throughout the majority of the quadrant. Large amounts of fill were present throughout, adding to the soil's compaction, and making it difficult to obtain soil profiles in this area. Cement or brick fill was found between 5-15 cm depth in every location examined. Much of the southwestern half of the quadrant contained a cement/limestone pad remaining from the original 19th century factory building, lying just inches under the surface, as well as bricks and other artifacts from the production and storage of materials on the site (Fig. 8).

Figure 8. Images showing the location of Quadrant 1, bricks and other artifacts found in the soil, and the heavily compacted soil characteristic of this part of the property.

Quadrant 2 was located in the southwest corner of the property (Fig. 9). Soil was compacted along the western street side, where it appears to have been mowed more regularly and has witnessed more pedestrian traffic. Horizons throughout the quadrant were clearly defined and included thick, silt loam topsoil horizons with silty clay loam subsoil horizons, much like the Web Soil Survey indicated. The topsoil horizon was much thicker in the southeast portion of quadrant 2. Also in the southeast corner, a thin surficial layer of rubble was encountered. This did not really affect the overall quality of the topsoil, however.

Figure 9. Images showing the location of Quadrant 2 and the relatively healthy soil that is found there.

Quadrant 3 is located in the southeast section of the property (Fig. 10). 3 soil units were recognized in this area. Unit A was decidedly the healthiest soil unit, as it was the least compacted, including a silty clay loam topsoil, underlain by a clayey subsoil horizon. Unit B similarly displayed topsoil with a silty clay loam texture underlain by a more compacted clay loam subsoil horizon. Unit C was our most compacted soil and we were unable to penetrate past 10 cm of gravel/fill. Our last sample was located in the southeastern corner of the quadrant. We believe it to be part of Unit 3, though it does have slightly different properties and was less compacted. It included small quantities of charcoal and pebbles.

Figure 10. Images show the location of Quadrant 3 and the relatively healthy soil that is found in the central and western part of that quadrant.

Quadrant 4 (Fig. 11) is located in the northeast corner of the property. Soil compaction is high in the western portion of this quadrant, with average compaction in north central portion of quadrant. The eastern part of the quadrant has low compaction due to abundant gravel in the subsurface. Soil in southwest portion of quadrant is mixed, back-filled soil that contains ceramic, glass and bricks. Soil in the southeastern portion of the quadrant has gravel scattered on the surface and throughout the subsurface.

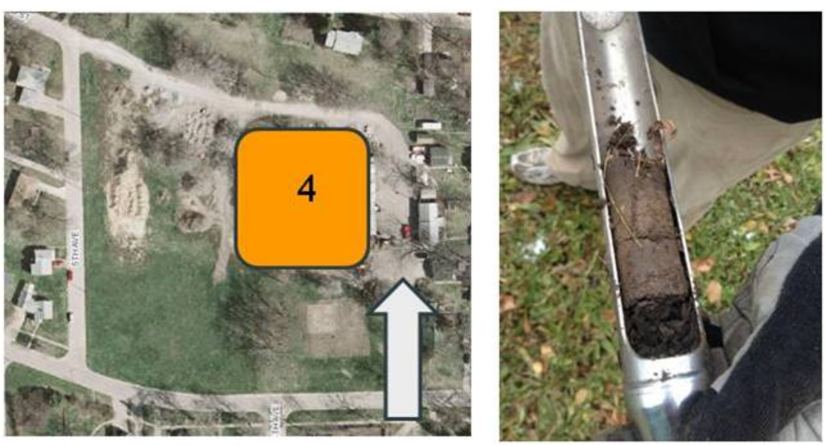

Figure 51. Images showing the location of Quadrant 4 and the heavily compacted soil typically found there.

Results from the lab tests performed on soil samples collected from the various soils encountered during our study showed that the chemical and physical properties of the soils were quite variable and that all soils on the property have some limitations for gardening (Fig. 12).

Figure 62. Lab data for bulk density, pH, and potassium levels of the soils on the Chadek property shows that there are multiple limitation for gardening present.

Healthy soils should have a pH between 6.5 and 7.0. We found pH was generally in this range in all but the northwest quadrant of the site. Ideal bulk density for garden soils should be lower than 1.55 g/cm^3. Much of the central and northeastern parts of the property were found to be too compacted for good gardening. Humus levels are low for the entire property, and electrical conductivity (EC) is also low for most of the property. EC should be a minimum of 0.2 mS in order to provide ideal plant nutrient availability conditions. The desired level of nitrogen for a garden is 40 ppm, overall the property has low nitrogen levels of about 10.5 ppm. Range of acceptable values for magnesium is 140-270 ppm, but the property has low Mg levels throughout of about 10-25 ppm. The acceptable value for potassium is 160 lbs/acre. Most of the property has sufficient levels of potassium, with the exception of the northeast and southwest quadrants which are relatively low.

According to the LSI report made by Terracon, all RCRA metals are below state wide standards. However, there is a relatively high concentration of waste oil at boring 2, B-2, and traces of other RCRA metals in B-1 (Fig. 13). This could be expected though, because boring site 2 is known to have been used as a parking space and boring 1 is the approximate location of the old coal burning furnace that powered the original factory. Other than that, their assessment indicated no areas of concern on the property.

Table 1: Results of TEH and RCRA Metals Analysis of Soil Samples (mg/kg)

Parameter	B-1 (0-4')	B-1 (10-12')	B-2 (10-12')	SWS for Soil
TEH				
Waste Oil	NA	<9.90	29.2	NA
RCRA Metals				
Barium	184	91.1	NA	15,000
Chromium	20.7	18.2	NA	97,000
Mercury	0.0229	<0.0235	NA	23

mg/kg = milligrams of contaminant per kilogram of soil
NA = not applicable

Table 2: Results of SVOC and RCRA Metals Analysis of Groundwater Samples (mg/L)

Parameter	B-1GW	B-2GW	SWS for a Protected Groundwater Source
SVOCs			
Bis(2-ethylhexyl)phthalate	0.000394	0.000557	0.006
RCRA Metals			
Barium	0.139	NA	2
Selenium	0.00721	NA	0.05

mg/L = milligrams of contaminant per liter of groundwater

Figure 73. Test results from The Limited Site Investigation performed by Teracon show traces of waste oil and other RCRA contaminants.

IV. Recommendations:

The Chadek property has the potential to be a great addition to the Iowa City Community's greenspaces. As a Community Garden, it would provide a space for the neighborhood to come together. A garden would provide the neighborhood with fresh produce, a place for children to learn about gardening, and an opportunity for citizens to better connect with their food and each other.

The property has had a long and varied history. The area was the site of various factories from 1895 until 1937. More recently, it was used as a dirt and gravel hauling site by Mr. Carl Chadek and as an informal playground and "discovery area" by neighborhood children. This history of diverse land use has led to a high degree of variability in the property's soils, and has resulted in soils in some parts of the property that what were once "prime farmland" soils to now be unsuitable for gardening.

In this document, we feel we have presented sufficient evidence to support our recommendation for what we believe to be the most suitable part of the property for a community garden. Due mostly to the fact that the northern half of the property is highly compacted and contains a large amount of fill and debris, and also due to the higher risk of contamination from waste oil and RCRA metals in certain locations, the area most suitable for a community garden is the southwest quadrant (Q2) of the property and the western 2/3 of the southeast quadrant (Q3) (Fg. 14).

Figure 84. Recommended area for a community garden on the Chadek property, restricted mostly to the south and, southwest portion of the property.

The only part of the southwest quadrant that might not be quite as suitable would be the narrow stretch along the streetsides that is slightly more dense and compacted, possibly due to it being mowed more frequently. The area to avoid in the southeast quadrant is the northeast part, were there is a higher risk of contamination from waste oil, according to the LSI analysis and along the alley where gravel and compaction will restrict use as a garden. Other than these two exceptions, this portion of the property is the most similar to the prime farmland soil series listed on the Web Soil Survey database.

While it is likely to be the best area for a garden on the Chadek property, the soils in the recommended area would still need to be amended to successfully accommodate gardening needs. On average, Nitrate, Humus, Potassium and Magnesium are low on that portion of the property. In order to enrich the soil, we recommend that the City of Iowa City add compost. The Addition of compost would raise the level of Nitrates, Humus and Magnesium in the soil, making the area perfect for gardening.

Other parts of the property, though not ideal for gardening, can provide good greenspace for a variety of outdoor uses. If turf grasses, trees and shrubs are to be grown in these areas we recommend aeration and “ripping” to decrease compaction and to provide better water infiltration. These areas would also benefit from additions of compost to increase organic matter and plant nutrient content, water holding capacity and soil health. We recommend several years of moderate to light compost additions worked into the soil via deep aeration to build the soil health.

V. Acknowledgements:

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Sources:

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4) Limited Site Investigation Report. Chadek property, September, 2014. Prepared for City of Iowa City. Terracon Consultants, Inc. Cedar Rapids, Iowa
5) http://www.agriculturesolutions.com/resources/92-the-why-and-how-to-testing-the-electrical-conductivity-of-soils
6) http://www.gardeners.com/how-to/building-healthy-soil/5060.html
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9) http://puyallup.wsu.edu/~linda%20chalker-scott/horticultural%20myths_files/myths/epsom%20salts.pdf
10) http://aes.missouri.edu/pfcs/soiltest.pdf
11) LaMotte Instruction Manual

APPENDIX

Laboratory data for Chadek Property soil samples

Sample	Bulk Density (g/cm^3)	pH	Conductivity (uS/mol)	Humus	Potassium (lbs/ac)	Nitrate indicator (ppm)	Nitrate strip test (mg/L)	Nitrite (ppm)	Magnesium (ppm)
1	1.07	7.8	0.19	low	300	60	25	0.5	1
2	1.66	7.9	0.31	low	220	150	0	0	1
3	1.5	8	0.11	low	300	60	5	1	1
4	1.22	8.4	0.32	low	150	60	25	0	2
5	1.35	8.2	0.3	low	500	60	25	0	1
6	1.17	6.7	0.03	low	300	100	25	0	1
7	1.3	6.5	0	low	100	150	25	0	1
8	1.27	6	0	low	50	100	10	0	2
9	1.3	7.2	0	low	50	10	0	0	3
10	1.41	6.9	0	low	220	150	10	1	1
11	1.4	7	0.03	low	50	100	1	0	2
12	1.37	8.3	0	low	170	20	1	0	1
13	**	6.6	0.019	low	110	10	1	0	1
14	1.79	6.8	0.014	moderate	50	15	0	0	2
15	1.36	8.6	0.01	low	50	15	5	0	3
** no bulk density – abundant gravel									