

**SITE SPECIFIC AGGREGATE RESOURCE EVALUATION**  
**Warroad Area**

**Part A: Summer Pit**  
**Part B: Ditch 10 Pit**

Minnesota Department of Natural Resources  
Division of Lands and Minerals  
William C. Brice, Director

Project 334-9  
March 2000

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Glenn D. Melchert  
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## Site Specific Evaluation—Project 334-9

### Part A: Summer Pit

NW/4, Section 29, T. 159N., R. 36W.

Lake of the Woods County, MN

**Client** – DNR Forestry, Warroad Area Office

**Purpose** – The purpose of this evaluation was to determine where the gravel resource extended from the existing pit. Extensive drilling was done adjacent to the pit to obtain information on the remaining resource so that it can be completely mined. Once portions of the pit were mined they would be reclaimed. The intended use of this product is class 5 aggregate for gravel road maintenance.

**Dates of field work** – September 20-22, 1999.

**Methods** – Twenty-four holes were drilled by DNR-LAM (Lands and Minerals) with a pickup-mounted power soil auger (Giddings Probe). A six-inch auger was used. An additional 20 holes were drilled by Dick Rossman using a 6-inch power auger pulled behind an ATV. This machine is called a Little Digger. All of the holes penetrated through the gravel deposit into till or fine to medium sand. Data from an older test pit dug by Dick Rossman was used.

All of the drill holes, the test pit, and the pit perimeter were located by GPS (differentially corrected).

Gravel samples from six holes were sieved for gradation analysis at the DNR-LAM office in Hibbing. Two other composite samples from the DR (Dick Rossman/Little Digger) holes were also analyzed. These data were compared to Class 5 specifications.

**Results** – The extent of the mineable gravel deposit is depicted on plates 1 and 2. The northern extent of the deposit was not defined due to a lack of time. A minimum thickness of 3 feet of gravel was used as the cutoff. The deposit trends north northeast and generally trends parallel to the contour between the 1250 and 1260 foot contour lines. The area covering the gravel deposit is forested with aspen, spruce and balsam fir.

The topsoil is no more than 0.5 feet thick over the gravel deposit. In most places topsoil directly overlies gravel. In other places a foot or so of gravelly sand overlies gravel.

On the west side of the gravel deposit the gravel thins fairly rapidly into till. On the east side the contact between gravel and gravelly fine to medium sand further east is transitional.

Down dip of the gravel deposit, which is to the southeast, 2 to 3 feet of fine to medium sand overlay 2 to 3 feet of gravel. This area was not included in the mineable gravel deposit because of the amount of material that must be stripped relative to the thickness of gravel is high. In

addition, the gravel is poorly graded, which means the gravel content (material larger than 10 mesh, or 2mm) is relatively low, the fine to medium sand content is excessively high, and the silt content is low.

Till directly underlies the gravel in the northwestern portion of the deposit and fine to medium clean sand underlies the gravel along the southeast portion of the deposit. This boundary is approximately defined by the dotted blue line in plates 1 and 2. Gravel west of the line overlies till and gravel east of the line overlies sand. The upper 6 to 12 inches of till appears friable enough so that it may be possible to incorporate it into the gravel as a source of silt.

**Quality** – Table 1 presents the raw data and Figure 1 shows how the gradations compare to class 5 specifications. These data only give a ballpark idea of the gradations because the samples used in the analysis may not accurately represent the deposit on a spatial basis. Some areas of the deposit were sampled more extensively than other parts. This is because we never intended to sample the deposit. The gradations show that the gravel deposit meets class 5 specifications except for a slightly high fine to medium sand content (passing 40 mesh) and a low silt content (material passing the 200 mesh sieve). Medium and fine sand are the predominant sand sizes in the deposit. The deposit averages 46% gravel and 1.8% silt. The minimum silt content necessary to meet class 5 specs is 3%.

Limited data indicate that there are not any lateral trends with respect to silt content.

The gravel deposit varies vertically in quality. One to two foot zones of sandy gravel or gravelly sand (low percentage of gravel) may occur anywhere in the deposit.

Significant amounts of unsound materials such as shale, iron oxide, ochre, and unsound chert were not observed in this deposit.

**Gravel volume estimates** – Figure 2 shows the gravel deposit divided into several tracts. The estimated volume of in-place gravel contained within each tract is presented in table 2. Estimates were not made for the gravel deposit more than about 500 feet north of the existing pit. The gravel volumes for tracts A through D have an error factor of about 20%. Near the center of tract E there is an area about 3 acres in size that is not drilled, which means there is a possibility there is no gravel in that area. Therefore, an error factor of 35% should be applied to tract E.

Table 1. Gradation results for the Summer Pit. Averages are weighted by depth.

HOLE	FROM (ft)	TO (ft)	Sieve size									
			1"	3/4"	3/8"	4	10	16	40	50	100	200
GP19	0	10.5	96	92	84	76	66	64	54	46	4	0.1
GP20	0.2	2.75	96	91	75	61	43	39	25	18	4	1
GP20	2.75	6.25	99	96	85	74	63	61	52	45	5	0.1
GP21	0.25	3.5	93	86	73	61	47	43	29	21	1	0.6
GP21	3.5	5.5	84	80	66	55	44	41	34	29	5	1.4
GP22	0	6.5	100	92	77	66	55	53	44	36	4	0.1
GP23	0.25	5.75	86	82	71	62	48	44	32	25	7	4.1
GP24	0	3	98	91	81	74	61	57	42	34	8	4.1
GP24 <sup>a</sup>	3	5.5	96	91	89	87	84	83	77	70	11	4.4
GP24 <sup>a</sup>	5.5	8	100	99	97	95	93	93	88	83	15	0.1
2E <sup>b</sup>			100	97	83	75	61	57	36	26	3	0.1
1W <sup>b</sup>			100	93	76	68	58	54	37	27	3	0.1
1-R <sup>c</sup>			89	85	74	67	53	52	41	34	4	1.7
2-R <sup>c</sup>			93	89	75	64	49	45	30	21	6	2.9
Deposit average (northwest area) <sup>d</sup>			91	87	74	66	51	48	36	28	5	2.3
Deposit average (northeast area) <sup>e</sup>			95	90	78	68	56	53	42	35	5	1.2
Deposit average (overall) <sup>f</sup>			93	88	76	67	54	50	39	32	5	1.8
Class 5 upper limits			100	100	90	80	65		35			10
Class 5 lower limits			100	90	50	35	20		10			3

<sup>a</sup> Samples not included in composite averages.

<sup>b</sup> Samples collected from stockpiles by Warroad personnel.

<sup>c</sup> Composite samples collected from the Little Digger holes.

<sup>d</sup> Simple average of 1-R and 2-R samples.

<sup>e</sup> Weighted average of GP19 through GP24 holes.

<sup>f</sup> Simple average of northeast and northwest averages.

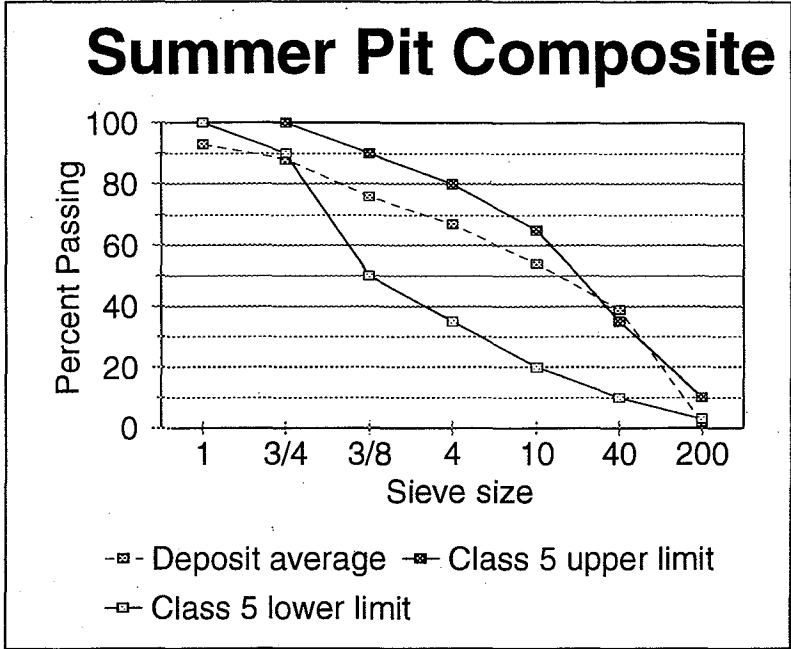


Figure 1. Graphic comparing gradation of the composited samples to the limits for class 5 aggregate. Values that plot between the upper and lower limits meet specifications. Materials larger than 3/4 inch are normally crushed.

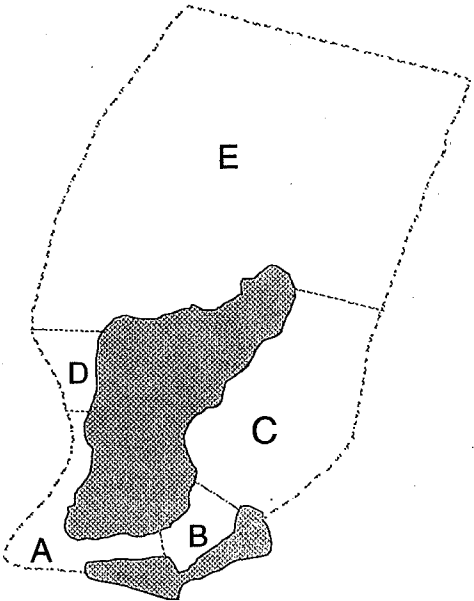


Figure 2. This illustration shows the gravel deposit divided into several potential mineable tracts. The tracts are labeled A through E.

Table 2. Volumetric gravel calculations for the tracts depicted in figure 2.

Tract	Area (ft <sup>2</sup> )	Acres	Thickness (ft)	Volume (yards)
A	37,200	.9	3.5	4,800
B	18,600	.4	4	2,800
C	126,300	2.9	4	18,700
D	18,100	.4	4	2,700
E	455,300	10.5	5.5	92,700
Existing main pit	147,800	3.4	trace	minimal <sup>1</sup>

<sup>1</sup> There is some gravel along the east side of the pit. The bottom 6 inches of the pit could be scraped for a source of silt.

The existing main pit covers about 3.4 acres. The smaller excavations to the south cover about 0.6 acres. With the exception of small amounts of gravel along the east side of the pit, all of the gravel appears to have been removed from the pit floor.

**Discussion** – This gravel deposit lacks silt in most places. It should be possible to increase the silt content to class 5 specs by incorporating about a half foot or so of the underlying till into the gravel during the crushing and stockpiling process. Till may be used if it is brown or yellow, but not blue or gray. In general, the yellow till is weathered enough and has enough sand and silt in it to break into small fragments. The small pieces are necessary for mixing with the rest of the gravel.

There is no till beneath the gravel along the east side of the deposit. This makes it more difficult to meet the silt requirement. I suggest that whenever gravel is mined from the east side, gravel should also be mined from the central or western portion of the deposit. Then gravel and silt from the west side can be blended with the gravel from the east side to obtain a better product.

When an area is opened to mining, the entire vertical section of gravel should be mined at the same time so that the deposit can be blended. This is because the quality of gravel varies vertically in places. If the deposit is mined in layers, the quality of the product will suffer when ever a sandy layer is being mined.



**Part B: Ditch 10 Pit**  
SE/4 Section 27, T. 161N., R. 36W  
Roseau County, MN

**Client** – DNR Forestry, Warroad Area

**Purpose** - Do reconnaissance drilling to determine if gravel reserves occur adjacent to the existing pit. The intended purpose of this product is class 5 aggregate for gravel road maintenance.

**Dates of field work** - September 22-23, 1999 (8 hours of drilling)

**Methods** - Nine holes were drilled with a pickup-mounted power soil auger (Giddings Probe). A six-inch auger was used. All drill holes, as well as the pit perimeter, were located by GPS (differentially corrected). Time restrictions permitted only a limited number of holes, so the strategy was to determine which directions the pit could be expanded. A few old test pits (about 3 feet deep) were found in the young pine plantation west of the pit. These pits indicated the gravel deposit extended some 800 feet west. GP2 (Giddings Probe hole #2) was drilled near the west end of the plantation to determine if there was substantial thickness to the deposit in this area. Five holes encountered significant gravel deposits.

Gravel samples from the five holes were sieved for gradation analysis at DNR–Lands and Minerals office in Hibbing. Data were compared to Class 5 specifications.

**Results** – Note that the results presented below are based on a very limited amount of data and the actual character of the gravel deposit may be substantially different than presented here.

Approximate limits of the deposit are indicated on Plates 3 and 4. The gravel deposit occurs where the ground is a few feet higher than the adjacent land to the north and south. The edges of the deposit are projected east and west based primarily on elevations. Pine trees are present east and west of the pit, but not on the north or south sides. This deposit trends west southwest and is about 400 feet wide from north to south. The gravel deposit pinches abruptly into fine to medium sand to the north and south near the existing pit. Drilling confirmed that the deposit may extend at least 200 feet east and 800 feet west of the existing pit. The average thickness of the deposit is 8.6 feet (range 6.5 - 10). Further drilling is necessary to define better the margins and thickness of the gravel, especially east and west of the pit.

Till was encountered at the base of the gravel in GP6 and GP9. Above the till in these holes was 1 to 1.5 feet of very silty gravel. This silty gravel and possibly the upper ½ to 1 foot of till are a potential source of silt. Fine to medium gray sand underlies the gravel in the other holes.

**Quality**– The gradations in Table 3 and Figure 3 show that the gravel deposit meets class 5 specifications except for silt. Silt is the material that passes the 200 mesh sieve. The deposit averages 51% gravel and 1.1% silt.

Table 3. Gradation results for the Ditch 10 pit.

HOLE	FROM (ft)	TO (ft)	Sieve size									
			1"	3/4"	3/8"	4	10	16	40	50	100	200
GP1	0	3	98	87	66	43	26	23	13	7	3	1.9
GP1	3	8	96	93	83	75	58	53	23	10	1	0.1
GP1	8	10	99	93	76	63	46	42	23	15	7	5.1
GP1 average <sup>1</sup>	0	10	97	91	76	63	46	42	20	12	4	1.6
GP2	0	8	89	85	74	62	51	48	28	13	1	0.1
GP5	1.3	11.5	93	89	80	71	47	41	23	13	3	1.1
GP6	0.5	9	99	96	89	78	55	49	31	20	3	0.1
GP9	2	8.5	100	97	92	82	60	55	39	27	7	3.1
Deposit average <sup>1</sup>			95	91	82	71	51	46	27	16	3	1.1
Class 5 upper limits			100	100	90	80	65		35			10
Class 5 lower limits			100	90	50	35	20		10			3
1N			100	99	82	72	60	57	38	24	2	0.1
2S			100	98	80	70	56	52	30	16	2	0.1

<sup>1</sup> These values are weighted by thickness.

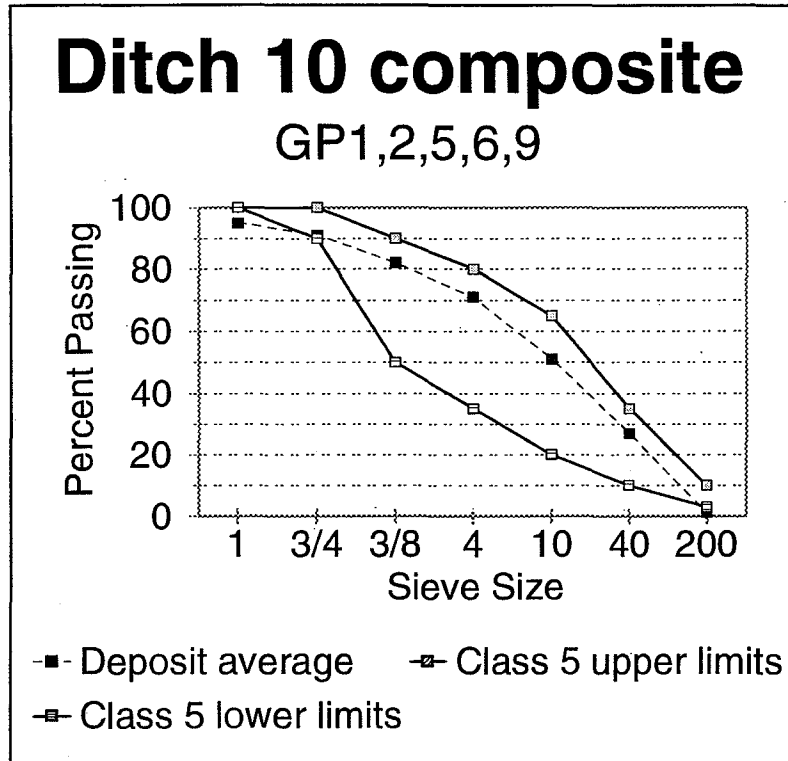


Figure 3. Graphic comparing gradations of the composited samples to the limits for class 5 aggregate. Values that plot between the upper and lower limits meet specifications. Materials larger than 3/4 inch are normally crushed.

The minimum silt content necessary to meet Class 5 specs is 3%. The only hole to meet that spec was GP9. The sample from this hole included 1.5 ft of very silty gravel from the base of the deposit. GP6 also encountered silty gravel at the base of the deposit. The silty gravel was not included in the sample, however. Analysis of GP1 indicates the siltiest gravel is at the base of the deposit. Other samples have almost zero silt.

The deposit varies vertically. The coarsest gravel usually occurs at the top or bottom of the deposit. Zones of sandy fine gravel that is 1 to 2 feet thick may occur near the middle of the deposit.

Significant amounts of unsound material, such as shale, iron oxide, ochre, and unsound chert were not observed in this deposit.

**Gravel volume estimates** – Due to a low number of drill holes, the following volume estimates are subject to an error factor of 50%.

With an average gravel thickness of 8.6 feet, each 100 ft by 400 ft band of area (moving east or west from the pit) could yield 12,700 yards of gravel. It is estimated the gravel deposit extends 800 ft west and 200 ft east. Therefore, simple volumetric calculations indicate there could be 100,000 yards west of the pit and 25,000 yards east of the pit. On a per acre basis, each acre would yield about 13,800 yards of gravel. There is potential for more gravel further east and west.

The existing pit covers about 3.2 acres. The pit was filled with water, so it is not known if all of the gravel has been mined from the bottom of the pit.

**Discussion** – Increasing the silt content should be a high priority. The gravel deposit appears to directly overly till along the north edge of the deposit. The upper foot of till is often gravelly and friable enough to be mined as a source of silt and mixed with the rest of the gravel. As a rule of thumb, if the clay is yellow, it may be ok to include with the gravel.

Given that the gravel deposit varies vertically, it is suggested that the mine be expanded in strips running from north to south and the entire thickness should be mined at the same time. This technique uses all of the resource and should provide a good quality gravel with the highest silt content. If the gravel is mined in layers, the quality will vary from good to poor (in terms of gravel content and silt content) depending on which layer is being mined.

This mining technique of mining in strips also allows for staged reclamation. By mining all of the useable resource from a portion of the pit before moving laterally, it is possible to perform final reclamation on the exhausted portions of the pit on a periodic basis rather than waiting on reclamation until the entire pit is mined.

Rock up to about 1.5 feet in diameter exists in this gravel deposit. Screening out the rock around 4 inches and larger during processing will not affect the quality of gravel from this deposit. This is because no rock larger than about 3 inches was used in the gradations and the gradations indicate this gravel is well within the specs for class 5 in terms of stone content. If screened rip rap is more valuable than gravel with slightly higher stone content, then the deposit should be screened to separate the rip rap from the gravel.

Overburden is the material that must be stripped off of the gravel deposit prior to mining. Here the overburden consists of fine to medium sand and topsoil. The overburden thickness is around a foot or less except in GP9. The overburden is 2 feet thick in GP9, and I hypothesize that it thickens rapidly further north. If the overburden is much thicker than 2 feet it may not be economical to mine the underlying gravel. This decision, however, is made on a case-by-case basis based on other supplies of gravel in the area, stripping costs, and possibly other land-use issues.

## Appendix 1

### Descriptions of auger holes

Appendix 1, Table 1. Drill hole descriptions for the Summer Pit.

DRILL HOLE	FROM	TO	GEOCODE	COLOR	% GRAVEL (visual est)	COMMENTS
GP1	0	0.75	soil	dark	0	
GP1	0.75	2	fine sand	lt brown	10	no silt, mostly granules
GP1	2	3	gravel	brown	30	no silt, pebbles to 3"
GP1	3	5	sandy grvl	brown	20	clean f sand matrix
GP1	5	7	gravel	brown	50	rocky
GP1	7	8	till	brown	10	lower part is blue gray
GP2	0	0.75	soil			
GP2	0.75	5.5	fine grvl	lt gray brn	30	sand matrix is most clean fine sand
GP2	5.5	7	till	blue gray	15	calcareous
GP3	0	0.5	gravel		40	lots of 3/4 to 2" pebbles
GP3	0.5	1.5	fine sand	lt brown	10	gravel is pea size
GP3	1.5	3.5	gravel	lt brown	40	lots of 3/4 to 2" pebbles, some coarse sand
GP3	3.5	9.5	till	gray	5	calcareous, sticky
GP4	0	0.5	fine sand	white	10	
GP4	0.5	3.25	gravel	brown	50	pebbles to 4"
GP4	3.25	4	till	gray		
GP5	0	1.5	sandy gravel	brown	25	match, pea, pebble
GP5	1.5	3	till	gray		
GP6	0	2	gravelly sand	brown	15	good gradation, mostly pea or smaller
GP6	2	3.5	till	brown		top foot is friable, lower 6" is gray brown
GP7	0	3	gravel	lt brown	30	pebbles to 2"
GP7	3	4.75	gravel	orange brn	40	good gradation
GP7	4.75	6	till	gray brown	10	weathered
GP8	0	3	gravel	brown	40	more f sand in upper
GP8	3	4	till	white gray		too much clay for binder
GP9	0	0.5	gravel	brown	35	
GP9	0.5	1.5	till	gray brown		
GP10	0	0.5	soil	black		
GP10	0.5	1	fine sand	dark brown	5	
GP10	1	2	gravel	brown	25	good gradation, pebbles to 3"
GP10	2	4.5	gravel	lt brown	35	f sand matrix
GP10	4.5	5.25	till	lt brown	10	
GP11	0	0.5	soil	black		
GP11	0.5	1.25	fine sand	gray brown	5	
GP11	1.25	2.25	gravel	brown	45	good gradation

GP11	2.25	3	till	white gray	5	mottles
GP12	0	0.25	soil	black		
GP12	0.25	2	gravel	brown	30	better gravel in lower part
GP12	2	3	till	gray white	5	
GP13	0	0.3	soil	black		
GP13	0.3	2	gravelly sand	lt brown	15	
GP13	2	4.5	gravel	brown	35	more gravel in lower
GP13	4.5	6	till	white gray	5	
GP14	0	1	gravel		35	rocks to 3"
GP14	1	4	gravelly sand	lt brown	20	all sizes to 3"
GP14	4	5.5	gravel	brown	60	rocky zone at 4 to 4.5'
GP14	5.5	6	till	brown	5	ok for silt
GP15	0	1	gravel	brown	45	good gradation
GP15	1	3	gravel	lt brown	35	pebbles to 3"
GP15	3	5.5	fine sand	white gray	5	
GP15	5.5	8.5	gravelly f sand	white gray	15	no silt, mostly granules
GP15	8.5	9	till	gray	5	firm, no good for silt
GP16	0	1	gravel	brown	35	good gradation
GP16	1	3	sandy gravel	gray brown	20	no silt, fine sand dominantly
GP16	3	10	gravelly f sand	gray brown	15	fine sand dominates
GP16	10	11.3	clay silt	gray	0	3 mm laminations
GP17	0	4	gravel	lt brown	30	mostly fine sand
GP17	4	7	fine sand	lt brown	10	no silt
GP17	7	8.5	till	brown	5	
GP18	0	0.1	soil	black		
GP18	0.1	2.5	gravel	brown	35	good gradation to 3"
GP18	2.5	3	gravelly sand	lt brown	20	no silt
GP18	3	9	gravel	lt brown	40	lots of 1.5 to 3" pebbles, fine sand matrix
GP18	9	10.5	till		10	
GP19	0	1.5	gravel	lt brown	30	
GP19	1.5	3	gravel	brown	50	excellent pebble content to 2"
GP19	3	8	gravel	lt brown	30	lots of 3/4 to 1.5"
GP19	8	10.5	fine sand	gray brown	15	hard drilling
GP19	10.5	11	till			
GP20	0	0.2	soil	black		
GP20	0.2	2.75	gravel	brown	60	some silt
GP20	2.75	6.25	gravel	lt gray brn	30	no silt
GP20	6.25	7.25	till	gray brown	10	
GP21	0	0.25	soil	black		

GP21	0.25	3.5	gravel	brown	60	occasional f sand streaks in lower ft
GP21	3.5	5.5	gravel	gray brown	45	lots of 1/2 to 3/4, several LS pebbles to 3to 6"
GP21	5.5	6.5	till	gray brown	5	upper is ok for silt
GP22	0	3.5	gravel	lt brown	55	half of the sand is white fine sand
GP22	3.5	5	gravelly f sand	lt brown gray	13	
GP22	5	6.5	gravel	brown gray	30	better gravel in lower part
GP22	6.5	7.25	till		7	
GP23	0	0.25	soil	black		
GP23	0.25	4.5	gravel	brown	45	some orange mottles at 2 - 3 ft
GP23	4.5	5.75	gravelly silt	brown	20	forms soft clods
GP23	5.75	6.5	sandy silt	brown	0	
GP23	6.5	7.5	till	gray	10	calcareous
GP24	0	3	gravel	brown	35	
GP24	3	5.5	gravelly f sand	lt gray brn	15	
GP24	5.5	8	sand	lt brown	10	mostly granules
GP24	8	9	fine sand		3	
GP24	9	9.5	gravel		40	less than 1/2"
GP24	9.5	10.5	till	gray		
TP1*	0	0.5	soil	black		
TP1	0.5	4	gravel			
TP1	4	4.5	till			

\* Test pit dug with a backhoe and described by Dick Rossman on 5/22/97.



Appendix 1 (con't), Table 2. Drill hole descriptions for the Ditch 10 Pit.

DRILL HOLE	FROM (ft)	TO (ft)	GEOCODE	COLOR	% GRAVEL (visual est)	COMMENTS
GP1	0	0.6	fine-med sand	dk brown	5	rare grvl, non-calcareous
GP1	0.6	3	gravel	brown	70	excellent gradation, mostly limestone
GP1	3	6	gravel	brown	45	grvl decreases to match and pea size in lower part
GP1	6	8	fine gravel	gray brown		mostly match and pea size
GP1	8	10	fine gravel	orange brown	40	slightly muddy, silt inc. with depth.
GP1	10	11.5	fine-med sand	gray	1	non-calcareous
GP2	0	0.75	fine-med sand	dk brown	10	
GP2	0.75	3	gravel	brown	55	pebbles to 1.5", no silt, more f sand with depth.
GP2	3	4.5	gravelly sand	gray brown	15	no silt
GP2	4.5	8	gravel	gray brown	40	no silt, most gravel smaller than 3/4".
GP2	8	9.5	fine sand	orange brown	3	v rare pea size, iron oxides present.
GP2	9.5	10.5	v fine sand	lt blue gray	0	no silt
GP3	0	0.5	soil			
GP3	0.5	1.5	fine-med sand	gray brown	2	no silt
GP3	1.5	2.5	fine-med sand	orange brown	2	
GP3	2.5	4	gravel	white/gray	35	pebbles to 1", silty
GP3	4	7.5	sand	brown	7	no silt
GP3	7.5	8	fine gravel	brown	30	match and pea only, no silt
GP3	8	9	fine-med sand	gray brown	10	no silt
GP3	9	11.5	gravelly sand	gray	20	few clay balls (till) in lower part
GP4	0	2	sand	gray brown		
GP4	2	3.5	sand	red brown	8	minor gravel to 3/4", silty
GP4	3.5	5.25	sand	lt gray	2	fine sand is dominant
GP4	5.25	6	sand	gray black	2	some silt
GP5	0	0.5	soil	dk gray brown	0	
GP5	0.5	1.3	fine-med sand	red brown	0	
GP5	1.3	1.8	fine gravel	brown	70	90% is pea and match
GP5	1.8	3	gravel	brown	35	
GP5	3	4	sandy gravel	brown	30	some pebbles to 1.5", no silt

GP5	4	7.25	fine gravel	brown	60	some pebbles to 1.5", silt in lower, mostly pea size
GP5	7.25	10	gravel	gray brown	40	numerous 1.5" pebbles, most sand is fine
GP5	10	11.5	gravel	orange brown	45	good gradation
GP5	11.5	14.5	fine sand	lt gray	45	poor recovery
GP6	0	0.5	sand	brown	0	
GP6	0.5	4.5	gravel	brown	50	lots of pea size, few pebbles to 1.5"
GP6	4.5	6	fine gravel	gray brown	40	mostly pea size.
GP6	6	9	gravel	brown	30	fine sand is dominant
GP6	9	10	gravel	gray brown	30	silty, gravel-till transition
GP6	10	12	till	brown gray	3	firm in lower foot
GP7	0	0.3	soil	black	0	
GP7	0.3	1.25	sand	dk red brown	3	
GP7	1.25	1.75	gravelly sand	white to brown	20	
GP7	1.75	4	sand	brown	4	
GP7	4	6	fine-med sand	brown white	0	no silt, mostly quartz, some black and red sand
GP8	0	1.5	soil mix	black/brown		disturbed surface soils
GP8	1.5	2	fine gravel	brown	30	all less than 3/4"
GP8	2	3.5	gravelly sand	lt brown	15	few 2 to 3" pea gravel zones
GP8	3.5	5	sand	gray brown	2	
GP9	0	0.3	soil	black		
GP9	0.3	2	fine-med sand	brown	0	
GP9	2	3.25	fine gravel	brown	60	mostly less than 3/8"
GP9	3.25	5.5	fine gravel	brown	35	
GP9	5.5	7	gravel		35	large pebbles/rocks.
GP9	7	8.5	silty gravel	brown	40	possible gravel-till transition
GP9	8.5	9	till?			no sample, very hard drilling

## DNR Drill Log

Minerals Project: 334-9 Site Specific Aggregate Mapping - Warroad Area Forestry

Date: Sept 20&21, 1999

Geologist/soil scientist initials: Dick Rossman (DR)

Equipment: Little Digger, with 6" auger

Legal Description: NW1/4 Section 29 T159N R36W

Site Description: **Summer Pit**

Drill hole # DR1		Location description: SE of pit area at end of dozer trail				
Depth (ft) _____ to _____		Sediment type Grain size	Color	Moisture (water table)	% Gr. %S	Notes
0	7ft	med & fine sands w/ occasional pebble	yellowish brown		1% 98%	
7'	8ft	dense clay loam	dark grey		- -	presumably glacial till

Drill hole # DR2		Location description: SE of pit area, second in from end of dozer trail				
Depth (ft) _____ to _____		Sediment type Grain size	Color	Moisture (water table)	% Gr. %S	Notes
0	7ft	med. & fine sands	yellowish brown	wet at about 5'	1% 98%	
7'	7.5'	Clay loam	dark grey			presumably glacial till

Drill hole # DR3		Location description: SE of pit area, 3 <sup>rd</sup> in from end of dozer trail					
Depth (ft) _____ to _____		Sediment type Grain size	Color	Moisture (water table)	% Gr. %S		Notes
0	8'	medium & fine sands	yellowish brown	wet at about 5'	1%	98%	Did not hit till at max depth of auger

Drill hole # DR4		Location description: SE part of pit area, just inside of berm					
Depth (ft) _____ to _____		Sediment type Grain size	Color	Moisture (water table)	% Gr. %S		Notes
0	5.5'	medium & fine sands	yellowish brown	moist	1	98	
5.5'	7.5'	Sand & gravel	brown	wet at about 5'	20	78	
7.5'		Clay loam	dark grey				presumably glacial till

Drill hole # DR5		Location description: East of pit area at end of dozer trail					
Depth (ft) _____ to _____		Sediment type Grain size	Color	Moisture (water table)	% Gr. %S		Notes
0	3'	med & fine sands		moist			
3'	5'	sand & gravel		wet at about 5'	15		
5'	7.5'	Sand with a few pebbles			1%		

Drill hole # DR6		Location description: East of pit area, second from end of dozer trail				
Depth (ft) to		Sediment type Grain size	Color	Moisture (water table)	% Gr. %S	Notes
0	3'	med & fine sands		moist	-	
3'	5'	sand & gravel with some 2-3" rock		wet at about 5'	25	
5'	7.5'	Sand with a few pebbles		wet	2	

Drill hole # DR7		Location description: East of pit area, just outside of berm on dozer trail				
Depth (ft) to		Sediment type Grain size	Color	Moisture (water table)	% Gr. %S	Notes
0	2.5'	fine & med sands		moist	-	
2.5'	5'	sand & gravel with some 2-3" rock		wet at about 5'	30%	
5'	7.5'	Sand with a few pebbles		wet	2%	

Drill hole # DR8		Location description: Southern part of pit area between berm & ponds					
Depth (ft) _____ to _____		Sediment type Grain size	Color	Moisture (water table)	% Gr.	%S	Notes
0	2	med sand with some gravel	whitish grey	moist	4%		
2	5'	med sand with gravel	grey	wet at about 4'	20%		decent gravel
5	7'	fine sand with some gravel	grey	wet	5%		not worth mining this depth

Drill hole # DR9/10		Location description: two holes together located SW of pit at end of old trail. Hole 9 was stopped by rock at 5.5' otherwise they were the same.					
Depth (ft) _____ to _____		Sediment type Grain size	Color	Moisture (water table)	% Gr.	%S	Notes
0	2.5'	Medium & fine sand		moist			
2.5	4.5	Sand & gravel	yellowish brown	water at 4.5'	25%		
4.5	6.5	Sand with fine gravel and significant clay, with occasional rocks		wet	5%		
6.5	7	Dark grey clay loam	dark grey	moist			presumably clay loam till

Drill hole # DR 11		Location description: On mid point of trail SW of pit area					
Depth (ft) _____ to _____		Sediment type Grain size	Color	Moisture (water table)	% Gr.	%S	Notes
0	5.5	Sand	yellowish brown		-		
5.5	7.5	Very fine SCL	light grey	wet at 4.5'	-		

Drill hole # DR 12		Location description: SW of pit area approximately 60 feet south of access road					
Depth (ft) _____ to _____		Sediment type Grain size	Color	Moisture (water table)	% Gr.	%S	Notes
0	2	medium sands					
2	3.5	Sand & gravel	light grey		40		
3.5	6	medium & fine sand with some gravel	yellowish brown		5		
6'	7.5'	Very fine sand clay loam	light grey		-		

Drill hole # DR 13		Location description: North of recently mined pit area, on dozer trail					
Depth (ft) _____ to _____		Sediment type Grain size	Color	Moisture (water table)	% Gr.	%S	Notes
0	.5'	Loamy sand	drk brown	moist	-		
.5'	4'	sand & gravel with frequent cobbles	dark yellowish brown		40%		
4	4.5	Sandy gravelly clay loam	"		30%		
4.5'	5.5'	Wet SgrCL	yellowish brown	wet at 4.5	25%		
5.5		Dense SCL till	med brown	moist	-		presumably glacial till

Drill hole # DR 14		Location description: North of recently mined pit area, on dozer trail					
Depth (ft) _____ to _____		Sediment type Grain size	Color	Moisture (water table)	% Gr.	%S	Notes
0	.5	LS topsoil	drk brown	moist			
.5	4.5	Sand & gravel w/ frequent cobbles	yellowish brown	moist	40%		
4.5	6	Sandy gravelly clay loam	"	wet at 4.5'	30%		
6'		Dense clay loam (till?)	Dark grey	moist	-		



Drill hole # DR 15		Location description: North of recently mined pit area, on dozer trail					
Depth (ft) _____ to _____		Sediment type Grain size	Color	Moisture (water table)	% Gr.	%S	Notes
0	.5	Loamy sand top soil	drk brown	moist			
.5	7'	sand & gravel	light yellowish brown	wet at 5'	45%		
7'	2.25	Dense clay loam	dark grey	moist	-		

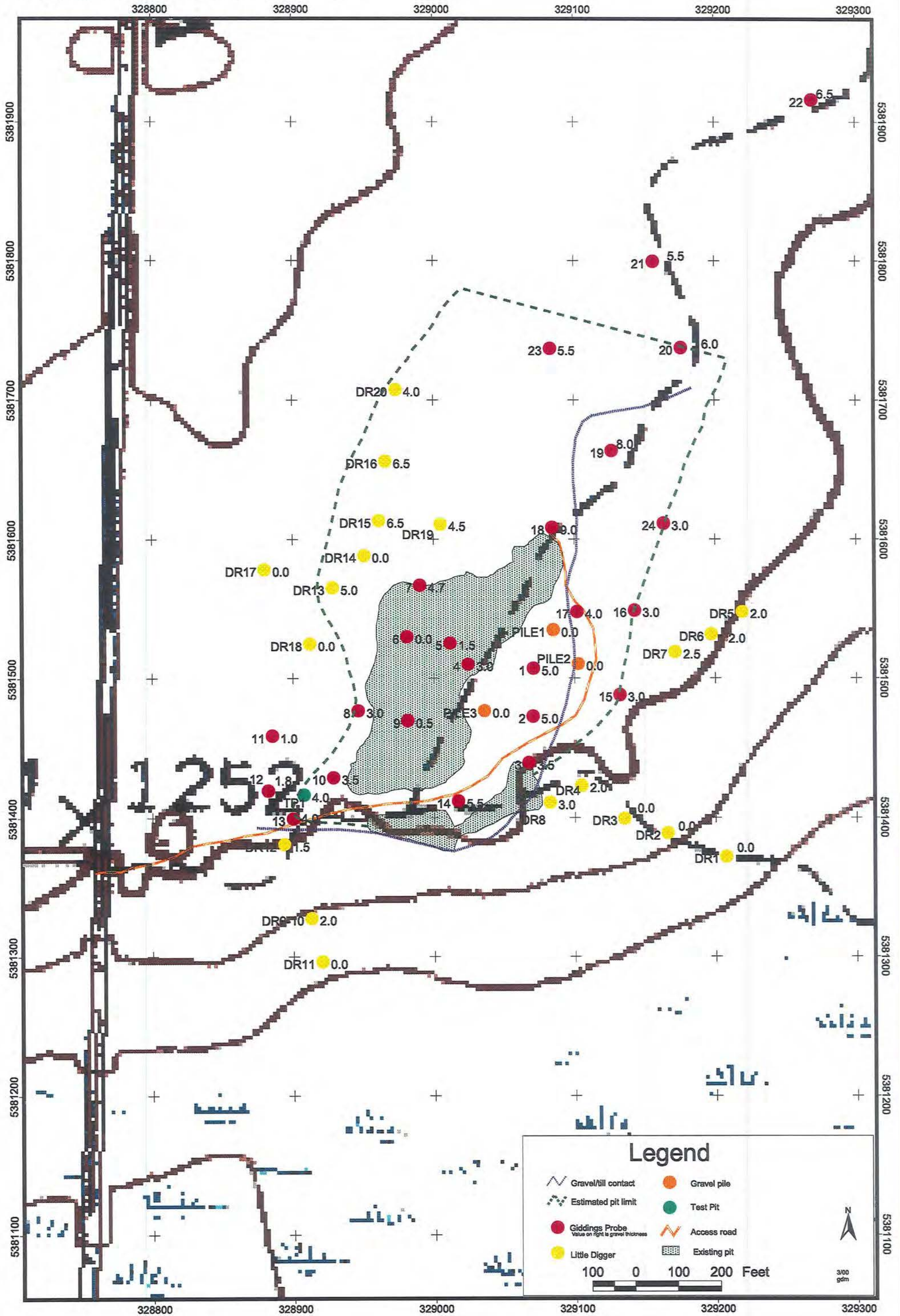
Drill hole # DR 16		Location description: North of recently mined pit area, on dozer trail					
Depth (ft) _____ to _____		Sediment type Grain size	Color	Moisture (water table)	% Gr.	%S	Notes
0	1	Sandy loam	drk brown	moist			
1	4.5	Sand & Gravel	yellowish brown	moist	40%	59%	
4.5	7	Sand & gravel	"	wet at 4.5'	30%		
7'	2.25	drk grey SCL	drk grey	moist	2		

Drill hole # DR 17		Location description: North of recently mined pit area, on dozer trail				
Depth (ft) ____ to ____		Sediment type Grain size	Color	Moisture (water table)	% Gr. %S	Notes
0	1	Sandy loam	drk brown	moist		
1	5	Sandy clay loam	yellowish brown	wet at 4.5'	0%	stopped by dense material

Drill hole # DR 18		Location description: North of recently mined pit area, on dozer trail				
Depth (ft) ____ to ____		Sediment type Grain size	Color	Moisture (water table)	% Gr. %S	Notes
0	1	Sandy loam	drk brown	moist		
1	4.5'	Sandy clay loam with 2% rocks (1-2" rocks)	yellowish brown	wet at 4.5'	2%	stopped by dense material

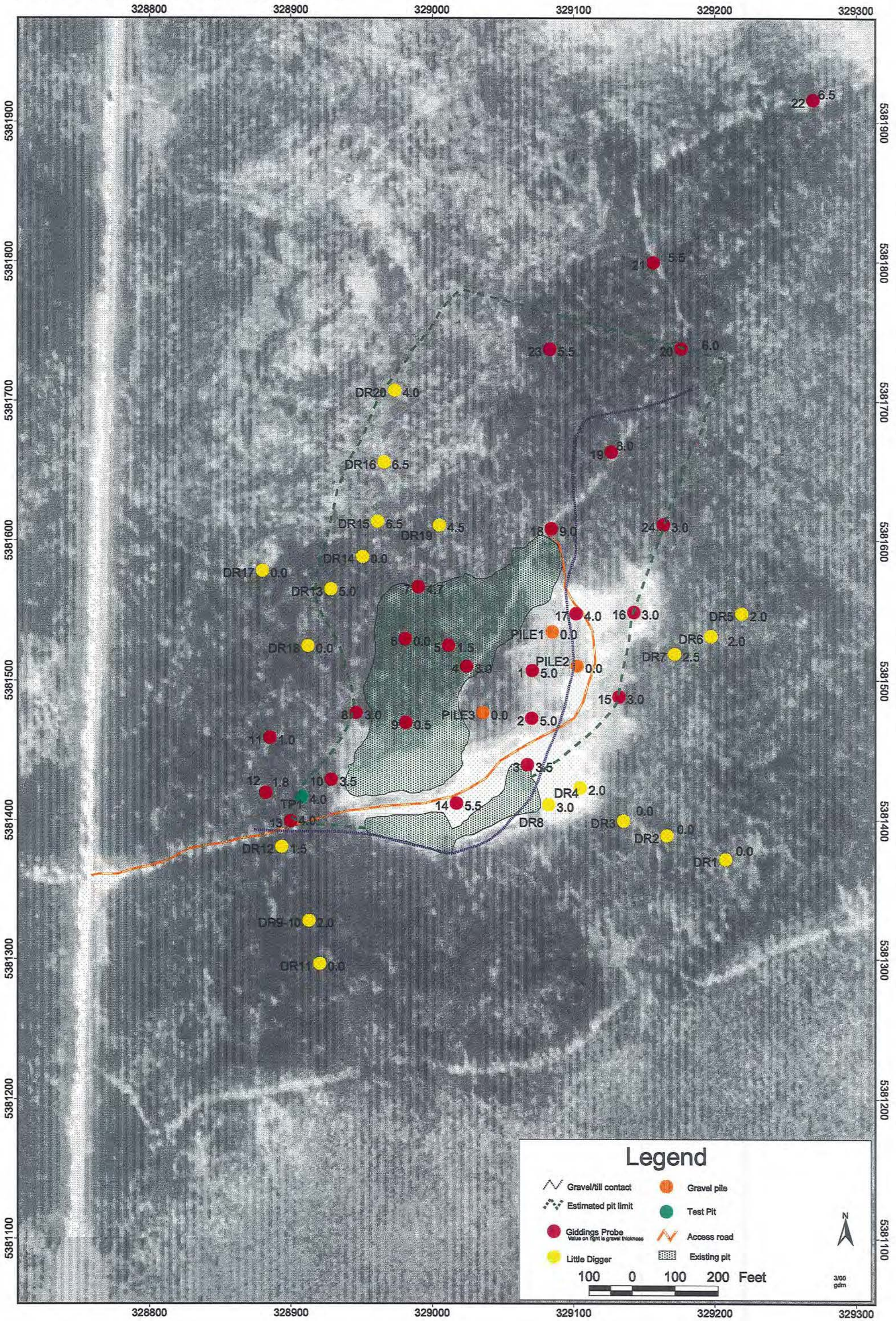


# Plate 1. Summer Pit



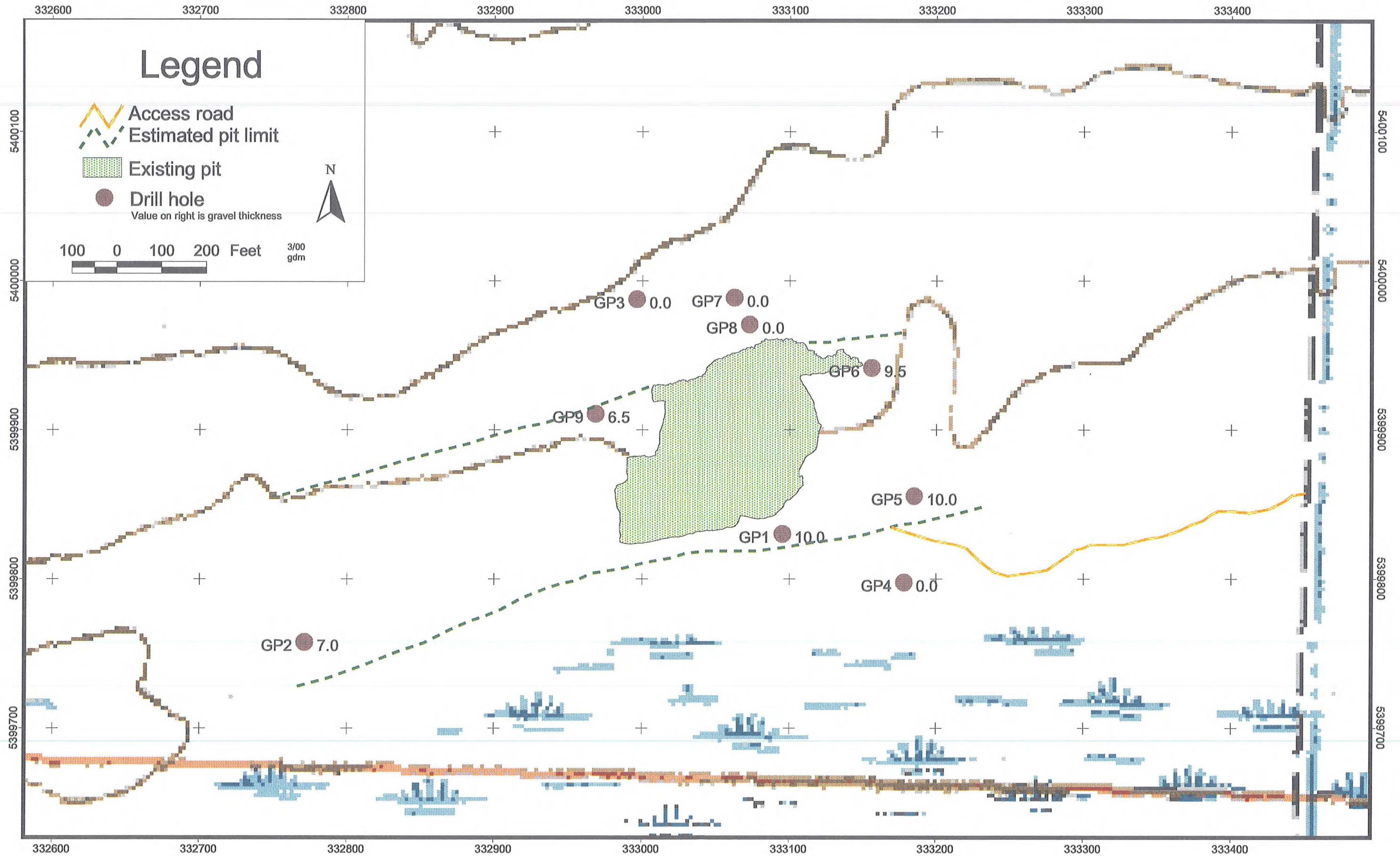


# Plate 2. Summer Pit





# Plate 3. Ditch 10 Pit





# Plate 4. Ditch 10 Pit

