# Sand Lake Watershed Studies Interim Report -

# Outline Summary of Findings related to Potential for Contaminant Transport from South Pond to Local Wells

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by
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Outline of findings regarding potential for contamination of local wells from South Pond:

## I. Potential Human-Introduced Contaminants in Urban Stormwater Runoff in Anchorage:

- pesticides, herbicides, trace metals, vehicle fluids, de-icing chemicals, sediment, and pet waste (fecal coliform bacteria) (Anchorage Waterways Council, 2014).

## II. Size Terminology

- 1000 millimeters = 1 meter
- 1000 microns = 1 millimeter
- Silt is defined as particles ranging in size between 4 and 62-74 microns.
- Viruses are less than 0.2 microns and bacteria are 0.4 to 2.5 microns in size.
- A playing card is about 300 microns thick (0.3 mm)
- Coarse silt is at the limit of what the unaided eye can see.

## III. Literature Review

Numerous studies have shown that particulate material can travel through aquifers.

- USGS study in Wyoming (Spangler and Susong, 2006):
  - shows silty water emanating from a spring
  - fluorescein dye showed that groundwater flowed 1.45 miles to turn a spring-fed pond green in one to two days at a velocity of about 8000 ft/day.

- Abundant research on the transport of viruses and bacteria through sand and gravel aquifers document transport for hundreds of meters (more than 1000 feet) - see figure below.

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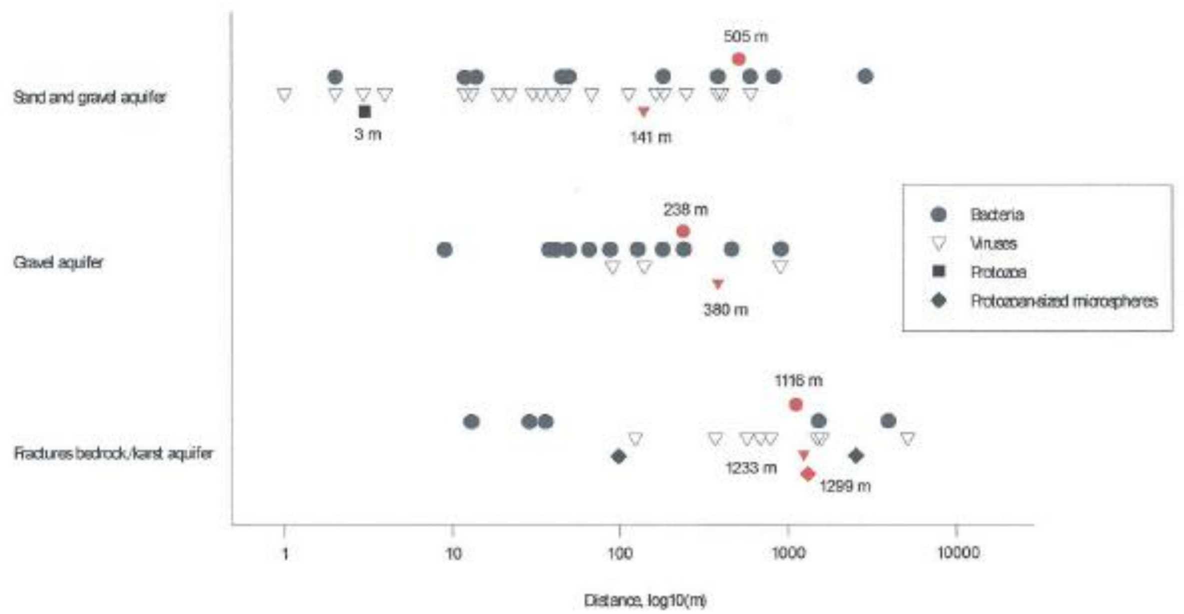
Figure Below:

Transport distance of pathogens in different aquifer matrices. Average travel distances are shown by red symbols. Data collected from the literature. (From Krauss and Griebler, 2011).

Fig. 3: Transport distances of pathogens in different aquifer matrices. The average travel distances are represented by red symbols. Data collected from the literature.

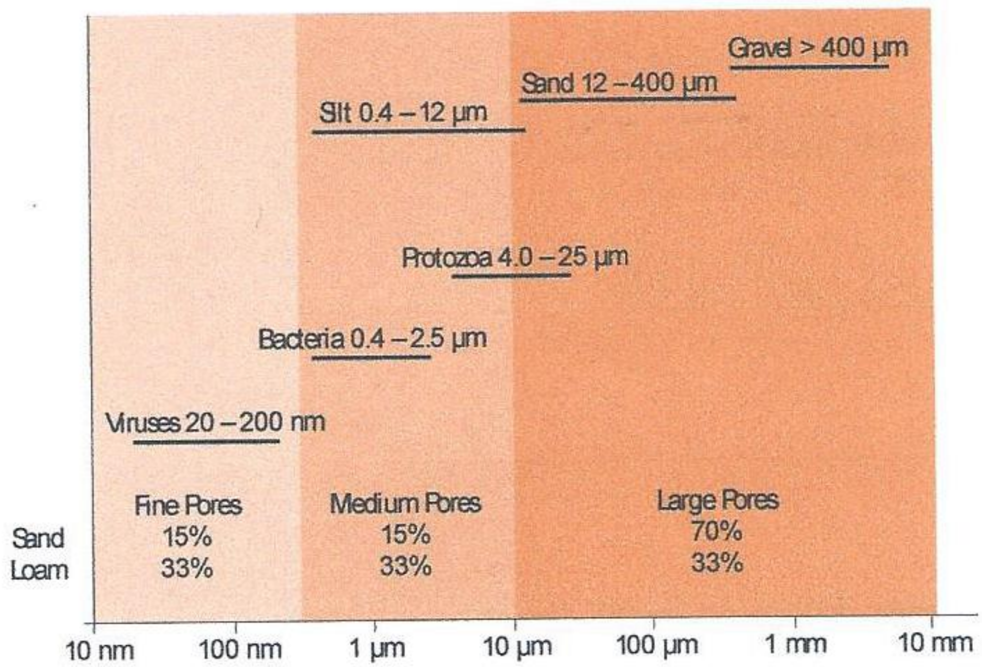



- These studies show that the transport of viruses and bacteria in sand and gravel aquifers for hundreds of meters is well documented.

## IV. Transport Processes

Chart shown below compares typical aquifer pore sizes with particulates of varying sizes. Fine silt particles, although not shown in the chart, are similar in size to protozoa and are smaller than pores in sand and gravel deposits with large pores by up to two orders of magnitude (factor of 100). Silt traveling through a large-pore sand and gravel aquifer could be compared to throwing ping-pong balls through basketball hoops.

Size range of pathogens compared to aquifer matrix characteristics (at the top are pore size ranges of silt, sand and gravel) (from Krauss and Griebler, 2011).




Resource: Adapted from Matthess and Pekdeger 1981.

## V. South Pond-Area Key Findings

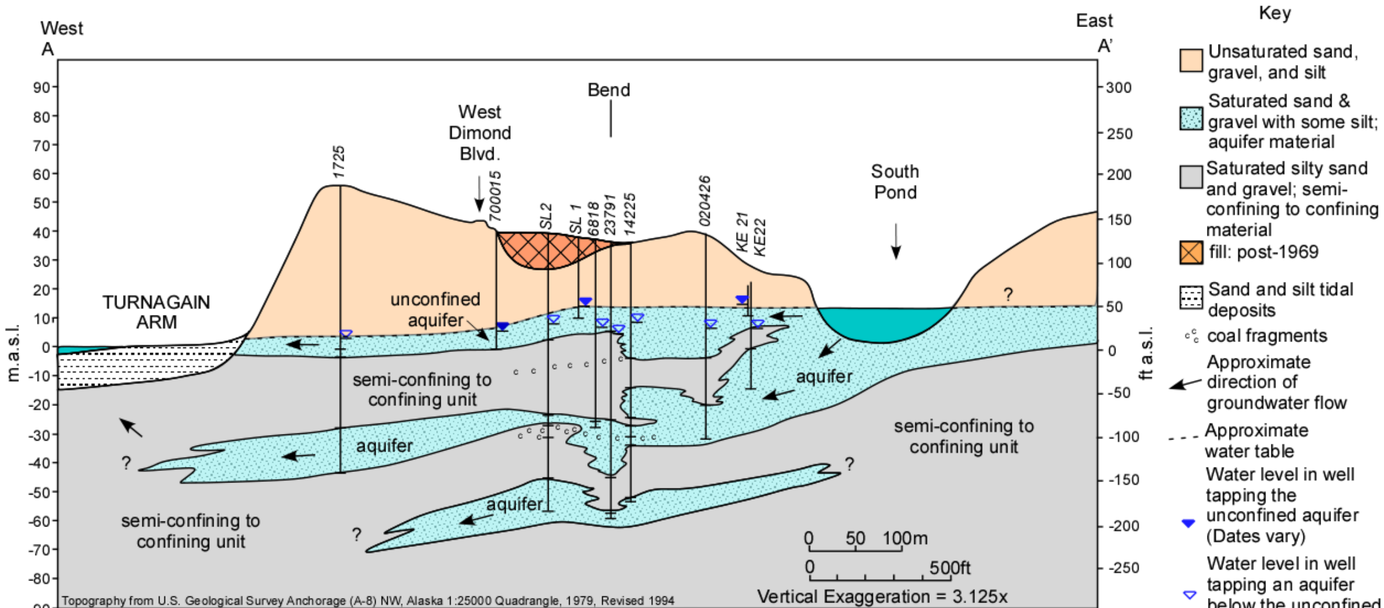
- The Dodds well reported problems during late 1970s (Dodds and Dodds, 2003 - see attached):
  - Unusual pumping of sediment 2.5-3 weeks after digging into aquifer.
  - Well cleared up until Westpark soil disturbance and major rainstorm of 2004.
  - The Dodds well does not normally produce sediment - only when pond is turbid.

- Kane et. al. (2008) study showed contamination of Dodds and other wells by tritium from recent (subsequent to 1952) groundwater recharge from atmospheric sources.

- TERRASAT INC. (2005) documented a 35-ft thickness of 50/50 mix of gravel/sand next to South Pond (see KE-22 well log attached). At least some of these materials would be expected to have "large pores" as shown above. Deposition of these materials by running water could result in high horizontal permeability along former channel-ways.

- Munk et al (2010) cross section (shown below) showed potential breach of confining layer and aquifer connection to Dodds well (Well 6818). This stratigraphy has been confirmed by current studies with additional test drilling and aquifer mapping.

Hydrostratigraphic cross section from Munk et al (2010):



Hydrogeologic Cross-Section A-A' of West Dimond Area. By: Munk, L., Munter, J., and Willems, B.
See Figure 1 for location.

- Controlled 24-hour aquifer test in 2016 at a well near WestPark Drive and Big Bend Loop northeast of the pond at rates up to 400 gpm showed aquifers have hydraulic connectivity up to 1500 feet away in four monitoring wells. The wells are located near Lucy Street northwest of the pond, KE-22 located west of the pond, and off of West Dimond southwest of the pond. Calculations using aquifer test and site data suggest groundwater travel time estimates of up to 80 feet/day. This suggests that "2.5-3 weeks" is plausible timeframe for transport from South Pond to Dodds well, a distance of approximately 860 feet.

- Transport of sediment from South Pond to Dodds well is concluded to be plausible as a result of observed discrete sediment-producing events, favorable hydraulic gradients, favorable aquifer materials, known groundwater transport processes, similar studies elsewhere, and potential breach of aquifer confining layers in the vicinity of the South Pond.

## VI. Prior Studies

- Munk et al (2004) did not find it plausible that the events described by Dodds and Dodds (2003) were related to the South Pond and concluded that "the sediment in these wells (the Dodds and Shantz wells) is likely mobilized in an annular space very near the well opening". They further commented, however, that "no concerted effort to study the soil and groundwater system in the Sand Lake area has been made. Therefore, many questions remain about the geology and hydrogeology of the area. This has a significant impact on ideas regarding the protection of the aquifers at the proposed Kincaid Estates Subdivision. Ideas about groundwater flow, chemical transport in the subsurface, and the concentrations of those chemicals are all based on an unclear understanding of the geologic and hydrogeologic system."

In particular, Munk et al (2004) did not consider: 1) the 2004 sedimentation event (the event happened after their report was written); 2) provided no explanation for the specific timing of the appearance of sediment in wells only a few weeks after the pond became turbid and not at other times; 3) did not consider the tritium findings from Kane et al (2008); 4) did not consider the results of test well KE-22 (see attached), which had not been drilled yet (it was drilled in 2005); and 5) did not consider the results of test drilling, geophysical studies, and aquifer testing and mapping conducted during the current 2013-2017 study. Thus, the findings of Munk et al (2004) relative to the potential contamination of the Dodds well from the South Pond are concluded to be out of date by not considering more recent substantive data and are not considered reliably useful or definitive at the present time.

- Kane et al (2008) described the hypothesis that turbid water in the South Pond was flowing through the aquifer to the (Dodds) well and yielding the turbidity in the well and concluded that "It is our strong opinion that this is not physically possible".

  Unfortunately, Kane et al (2008) did not correctly understand or identify the geological stratigraphy of the site. They made no use or mention of the well log of KE-22 and appear not to have used it in their analysis. The log of KE-22, penetrating a 35-foot thickness of gravel and sand, is a key data point that defines the stratigraphic relationships immediately downgradient of the pond (see Munk et al 2010, Figure 2) and provides substantial evidence for the transport of silt-sized material through the aquifer. For example, none of their hydrogeologic cross sections go through the pond. Furthermore, Kane et al (2008) does not produce a plausible alternative that would explain the observed historical facts. The Kane et al (2008) conclusion described above, therefore, based on an incorrect hydrostratigraphic framework and overlooking the potential for contaminant transport through a significant sand and gravel aquifer, is concluded to be unreliable.

- Munk et al (2010) prepared a hydrogeologic cross section through the South Pond and concluded..."that the shallow and mid-depth aquifers (tapped by the Dodds and other wells) appear to be susceptible to surface contamination and that efforts to avoid or minimize future contamination of these aquifers are warranted." This conclusion has been confirmed and expanded upon by the current work.

## VII. Conclusions

- Munk et al (2004) and Kane et al (2008) do not present thorough hydrogeological analyses compared to what is currently possible and their conclusions and opinions regarding the potential transport of contaminants from the South Pond to local wells should not be relied upon.

- Transport of sediment from South Pond to Dodds well is concluded to be plausible as a result of two observed and recorded sediment-producing events, favorable hydraulic gradients, favorable aquifer materials, known groundwater transport processes, literature studies of particulate transport through aquifers elsewhere, and a likely breach of the aquifer confining layers in the vicinity of the South Pond.

## VIII. References Cited

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Munk L. A., J. A. Munter, and B. A. Willems, 2010. Sand Lake Area Groundwater: Geochemistry and Aquifer Connectivity: A report to Anchorage Waterways Council, University of Alaska Department of Geological Sciences.

Spangler, Lawrence E. and David D. Susong, 2006, Use of Dye Tracing to Determine Ground-Water Movement to Mammoth Crystal Springs, Sylvan Pass Area, Yellowstone National Park, Wyoming. U. S. Geological Survey Scientific Investigations Report 2006-5126
.

TERRASAT, Inc., 2005, Letter to Dan Roth, Municipality of Anchorage, Re: WestPark Subdivision Monitoring Well Results for KE-21, KE-22 and the Southern Pond, December 12, 2005, 1 page plus attachments.

Attachments: KE-22 Well log
Dodds and Dodds (2003) affidavit

# WELL CONSTRUCTION LOG

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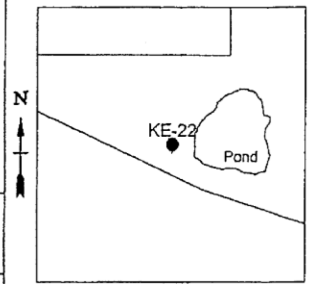


| | |
|---|---|
| WELL NUMBER | KE-22 |
| PROJECT NUMBER / NAME | 20104A / Kincaid Estates |
| LOCATION | Sand Lake Gravel Pit<br>Anchorage, Alaska |
| CLIENT | White Raven Development Inc. |
| DATE DRILLED | 6/16/05 - 6/17/05 |
| DRILLING COMPANY / METHOD | MW Drilling / Air Rotary |
| LOGGED BY | Jessica Blackledge |

| ELEVATION OF: (FT. ABOVE MSL) | GROUND SURFACE | TOP OF WELL CASING | TOP & BOTTOM of SCREEN | GW SURFACE ▼ | DATE ▼ |
|---|---|---|---|---|---|
| | | | | | 6/17/05 |

| SAMPLE ID. | EXTENT | DEPTH (ft. BGL) | U.S.C.S. | GRAPHIC LOG | LITHOLOGIC DESCRIPTION | CONTACT DEPTH | TEST RESULTS |
|---|---|---|---|---|---|---|---|
| GRAB 1 | | 0–20 | ML | | SANDY SILT (ML): olive gray and light olive gray, about 5% fine gravel; about 35% fine to coarse sand; about 60% fines, nonplastic; no odor. | 20.0 | |
| GRAB 2, GRAB 3 | | 20–30 | ML | | SILT (ML): olive gray, about 20% fine to coarse sand; about 80% fines, nonplastic; no odor | 30.0 | |
| GRAB 4 | | 30–37 | ML | | SANDY SILT with Gravel (ML): olive gray, about 20% fine to coarse, angular gravel; about 30% fine to coarse sand; about 50% fines nonplastic; no odor, Gravel to 3/4 inch | 37.0 | |
| GRAB 5, GRAB 6 | | 37–50 | SM | | SILTY SAND (SM): olive gray, about 5% fine, subangular gravel; about 65% fine sand; about 30% fines; no odor, Gravel to 1/2 inch | ▼ 50.0 | |
| GRAB 7, GRAB 8, GRAB 9 | | 50–75 | ML | | SILT (ML): olive gray, about 10% fine to coarse sand; about 90% fines nonplastic; no odor | 75.0 | |
| GRAB 10 | | 75–82 | SM | | SILTY SAND (SM): dark gray about 50% fine to coarse sand; about 50% fines; no odor | ▽ 82.0 | |
| GRAB 11 | | 82–85 | SM | | SILTY SAND with Gravel (SM): medium dark gray with olive gray, about 20% fine, subrounded gravel; about 40% fine to medium sand; about 40% fines; no odor, Water and gravel encountered. Gravel to 1/2 inch.. | 85.0 | |
| GRAB 12, GRAB 13, GRAB 14, GRAB 15 | | 85–120 | GP | | GRAVEL with Sand (GP): dark gray with olive, about 50% fine to coarse, angular to rounded gravel; about 50% fine to coarse angular sand; no odor, Gravel to 1 inch. Coal chunks up to 3/4 inch. | 120.0 | |
| GRAB 16 | | 120 | | | Bottom of borehole at 120.0 feet | | |

BORING / WELL / TEST PIT LOG KINCAID ESTATES KE-22 AND 23.GPJ TERRASAT.GDT 12/6/05

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Copies

## AFFIDAVIT

STATE OF ALASKA
MUNICIPALITY OF ANCHORAGE

We, Loren and Betty Dodds, residing at 8705 Sommers Place, Anchorage, Alaska 99502, being duly sworn, state as follows:

We were living on Sommers Place in the 1970's when gravel mining took place in the Sand Lake gravel pits. Prior to this time and during this time to the best of our recollection the following events took place:

1. May, 1966. We purchased 3 lots with a mobile home on Sommers Place. The well on the property was dug in 1965.
2. Summer 1967. Dave Dilley, Betty Dodds's brother, bought two lots adjoining ours. Put a mobile home on one lot and connected to our well.
3. 1971 Dilleys built a 4 bedroom house on their other lot. The new house was also connected to our well. Renters moved into their mobile home..
4. 1972 We started building a 4 bedroom home on our other lot. The new home was connected to our well. We moved into our new home in January, 1973. Renters moved into our mobile home.
5. Four families were now getting their water supply from our well. The water was hard with lots of iron, but otherwise there was no cloudiness or high levels sedimentation with the water.
6. In the mid-1970's Mike Stephens, a local contractor, discovered a vein of high grade gravel in the south west corner of the pit. He kept digging in this area until he reached the water table. He brought in a dredging machine and kept digging until he created the "pond" which is at the center of this current controversy. In 2 ½ -3 weeks we began to notice a film of sediment in the toilets and bathtubs. At this time it became obvious that there was a connection between gravel mining operations in the pit and the cloudiness and sedimentation in our water.
7. The pump in neighbor Dan Shantz's well seized up and burned out. The pump as well as the hot water heater had to be replaced.
8. Stephens' gravel mining permit expired in the fall and the dredging stopped. Our water began to clear up, and within 5 –6 weeks was no longer cloudy.
9. In the spring a new gravel mining permit was applied for.
10. Loren Dodds and Russell Backheus, another neighbor, attended a Planning and Zoning meeting to protest the issuance of this permit. The Planning and Zoning Commission acknowledged that there was a relationship between our cloudy water and the gravel mining and would not issue a permit.
11. Stephens offered to put a filtering system on our well and when we agreed to his plan, he was issued a permit. Because of financial problems and some of the equipment being lost, no mining activities took place after the filter was put on the well.

Exhibit F
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12. May, 1977. Our well became a community well when the Department of Commerce and Economic Development issued Articles of Incorporation establishing Seaview Heights Water Association, inc. The PWS I.D.# is 214798.
13. We have records of Coliform tests on our well from September, 1986 to February, 2003. All tests were satisfactory. A nitrates test was done in August, 2002. No nitrates were detected. An arsenic test done in March, 2001, showed results of 9.4.
14. We have letters from Dan Shantz, Phyllis Backhaus and Karla Korman who lived on Sommers Place during this time. Their letters bear witness to the problems we had with our water during this time due to gravel mining in the Sand Lake gravel pit.

Loren Dodds

Betty Dodds

Subscribed and sworn before me this 17th day of November, 2003.

Notary Public

KATHRYN HELD NOTARY PUBLIC STATE OF ALASKA

Exhibit F
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