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REVIEW OF A CONSULTANT'S REPORT ON SEPTIC SYSTEM CONTAMINATION AT ANCHORAGE, ALASKA, WITH INTERPRETATIONS OF DATA

By
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INTRODUCTION

Hart Crowser, Inc. (1987) presented the results of an investigation of surface and ground-water contamination in the Little Campbell Creek drainage basin in the Anchorage hillside area. In response to a request from the Municipality of Anchorage (Appendix A), this report presents a review of the Hart Crowser, Inc. (1987) report, with interpretations of data contained therein.

Part 1 of this report presents a summary of the most significant observations and interpretations made during the review. Part 2 of this report presents detailed comments regarding specific statements or data contained in Hart Crowser, Inc. (1987) that support the observations and interpretations contained in Part 1.

ACKNOWLEDGMENTS

This report was prepared utilizing valuable observations of Stan Carrick, Mary Maurer, Bill Long, Robert Forbes (all of DGGS), Lee Browning of the Municipality of Anchorage Department of Health and Human Services, and Mary Frohne.

PART 1. SUMMARY OF OBSERVATIONS AND INTERPRETATIONS

1. The report does not adequately address the objectives or methodologies of the investigation, the rationale for selecting methodologies, or the hydrogeologic setting of the area under investigation.

2. The report provides documentation showing that numerous septic systems are improperly designed or improperly installed.

3. Ground-water quality data presented in the report indicate that shallow ground water may be affected by septic system usage. A lack of information on "pristine" water quality (particularly regarding nitrates) in this area and the short period of record available from the observation wells precludes a more quantitative assessment.

4. The report presents a relatively dense network of data compared to previous investigations in South Anchorage. These data indicate that the bulk of the fecal coliform bacterial contamination problem of the Little Campbell Creek drainage basin is probably unrelated to areawide shallow ground-water contamination by septic systems. This interpretation is supported by:

   a. Stream contamination is very low just upstream of a horse paddock (SS-4A) an is very high downstream (SS-4).

   b. Concentrations of stream contaminants are highest during high flow conditions, suggesting a positive relationship between contamination and surface runoff. During base flow conditions in December, concentrations of stream contaminants are low.

   c. A cursory examination of 62 individual septic systems and a detailed investigation of 12 systems (at which 2 or more monitoring wells were drilled) revealed only one system with confirmed contamination of ground water and no systems that are conclusively shown to have violated the four-foot separation distance between the bottom of the system and the water table. Where ground water is contaminated, fecal coliform bacteria counts are lower than counts at a nearby stream sampling station (SS-4), which is opposite of what would be expected if ground water is the source of the contamination.

Contaminated ground water is typically diluted as it moves and discharges to streams.

d. Fecal coliform and fecal streptococci bacteria occur in the intestines of warm blooded animals and are not specifically indicative of septic system contamination.

e. Of the ten wells installed in road right-of-ways and sampled, none exhibited any reproducible bacterial contamination.

5. Continued collection of water-level and water-quality data at observation wells will be critical to the successful identification of seasonal water-level fluctuations and ground-water-quality trends. Wells sited to provide water-quality data near septic systems may be unsuitable for detecting natural seasonal water-table fluctuations because ground-water levels may be significantly influenced by wastewater loading.

6. Data contained in the report demonstrate substantial variability (up to 12 ft) in the position of the water table at different locations adjacent to some septic systems. This phenomenon is caused principally by the considerable geologic variability that exists in the study area. In the "recommendations" section of the report, a program of study is outlined that makes no consideration of this variability. The program of study proposes the creation of a "high" water table map that may be substantially in error and of highly questionable utility for site-specific evaluations, as is proposed.

7. The study did not sample any of the numerous springs or seeps that occur in the study area. This results in an incomplete description of the

extent of surface and shallow ground-water contamination, and prohibits positive linking of stream contamination with shallow ground-water contamination. The advantages of investigating springs and seeps have been described in previous correspondence between the Division of Geological and Geophysical Surveys and the Municipality of Anchorage (Appendix B).

8. Most of the observation wells installed during this study contain 15 ft of slotted casing and may themselves have a material effect on the position of the water table. The water table observed in these wells represents a composite water table integrated over the depth interval monitored. Observations of the "seasonal high water table" using data from these wells may result in artificially low values. The wells, especially those placed near septic systems, may also be conduits for the downward migration of contaminated ground water at shallow (less than 20 ft) depths through the slotted portion of the casing. These types of problems are commonly avoided by constructing wells with five feet or less of screen or perforated casing. The collection of detailed information at septic system installations may require the use of nested piezometers (Canter and Knox, 1985, p. 89).

9. The Municipality expended considerable energy to identify sites for observation well installations using available soils, geologic, topographic and other maps (R&M Consultants, 1986, Appendix B). It is not clear whether this information was used in the current study, because no rationale for siting of the 18 wells located in road right-of-ways is provided.

10. A review of the data contained in the Hart Crowser report indicates that stream contamination in the Little Campbell Creek drainage basin may be caused by a few discrete surface or shallow subsurface sources such as animal impoundments or failing septic systems. If the objective of the investigation was to identify these sources, then searching for them by means of observation wells is a relatively inefficient process because of the large area involved and the small volume of the subsurface that can be characterized with any single well. A more efficient method would consist of a more intensive surface water sampling in seeps, springs, rivulets and ditch tributaries to track contamination levels upstream until specific source areas are identified. This method is likely to work only if significant and isolated sources exist. If significant and isolated sources do not exist, and if septic systems occur in the area, then installation of monitoring wells is a logical alternative.

11. The text of the report states that a literature search was conducted. The report contains no list of references.

In summary, the Hart Crowser report provides important information concerning the contamination of ground water and streams in the Little Campbell Creek basin by nitrates and fecal coliform and fecal streptococci bacteria. The authors state that "Hart Crowser, Inc. has completed the initial phase of a long-term study designed to identify sources and extent of pollution of surface waters and subsurface waters in the Little Campbell Creek drainage area". The Hart Crowser report lacks several fundamental components that are typical of reports resulting from this type of study including:

statement of problems, objective(s), methodologies, and study area description. The lack of these components seriously limits the utility of the report for identifying sources and extent of surface and ground-water contamination in the study area. In addition, numerous technical problems detailed in Part 2 of this report indicate a general lack of technical review.

The title of the Hart Crowser report suggests that the major focus of the study was to determine the extent of septic system contamination of shallow ground water and surface water. Significantly, no septic systems were implicated by this study as major contributors to surface-water contamination, and minimal ground-water contamination was found. The methodology utilized during this investigation is concluded to have been an ineffective means of identifying individual septic systems that may be significant contributors to stream contamination.

PART 2. REVIEW COMMENTS

Hart Crowser, Inc., 1987, Investigative study for determining pollution of surface and subsurface water by on-site septic systems: Unpublished report for Municipality of Anchorage Department of Health and Human Services A-8085, 24 p., plus appendices.

Page/Paragraph

1-3/all The "Introduction" of the report does not adequately address the objectives and methodology of the study. Specifically:

a. Previous studies describing contamination of Little Campbell Creek basin are not described.

b. The rationale for focusing on septic systems during the "initial phase" of the study rather than surface sources of contamination is not provided.

c. A description of the various phases of the long-term study is lacking, with no description of how the initial phase fits in.

d. The criteria for selecting 62 lots within 9 specified subdivisions are not provided. Numerous other properties occur in the area, yet are not included in the study.

e. The study area and drainage boundaries are not described. Audubon Hills subdivision, for example, occurs outside of the sub-basin that contains all stream sampling stations. What geologic materials occur in the area that are used for receiving septic system waste?

f. The criteria for selecting monitoring well sites are not described.

g. "Certain creeks in several subdivisions" should be explained further.

h. The criteria for selecting stream sampling stations is not described.

5/1 It is not clear how surveyed stream locations contribute to the investigation of the "pollution of surface and subsurface water by on-site septic systems". Have the streams moved or been moved significantly since preparation of the 1974 topographic maps? Is the information mainly for monitoring compliance with 100 ft setback requirements? Why were "certain portions of several creeks" studied?

7/1 Correlation between contaminant levels and flow in the creek cannot be made using "General comments regarding depth of flow in the area sampled" without information about the velocity of flow. Both depth and velocity measurements are needed to make discharge estimates. Correlations between contaminant levels and "flow" were not clearly identified in the analysis portion of the report.

7/2 The determination of "nonconforming systems" appears to be inexact. Use of the method as a screening device is appropriate, but this should be stated.

12/1 Criteria for timing of sampling relative to climatic events should be addressed. Were samples taken in the rain?

12/2 The description of the sources of the bacteria S. faecalis, subsp. liquefaciens is not entirely consistent with the description provided by the U.S. Environmental Protection Agency (1978, p. 151). Sources of information should be provided. The conclusions of Hart Crowser (1987) regarding this matter are not materially affected, however.

13/1 The number of domestic water samples collected and analyzed should be specified.

13/2 Conclusion 6 is vague and inadequate. Naming several subdivisions that "require additional study" is an unwarranted extrapolation of data. A review of the monitoring well data collected at 12 on-site systems suggests that one site exhibits confirmed contaminated ground water, and three other sites show anomalous bacteriological counts. No sites are shown to violate the required 4-ft separation between the bottom of the trench and the water table. Of 27 homeowner interviews, 3 indicate shallow ground water may be a problem with their systems.

14/2 The phrases "appears to be subject to" and "seems to be subject to" are vague. How is the conclusion reached? Is this a recommendation?

14/3 Conclusion 9. "Numerous" failing systems is vague and should be replaced with a more specific description.

14/4 Conclusion 10. Contamination of test well 26 is at a very low level and is unconfirmed. It is not standard practice to state that a well is contaminated with only a single bacteriological analysis. Surface sources of contamination in Trails End subdivision are also "significant potential" sources. The inclusion of a recommendation for "additional study" is inconsistent with the labelling of this section as "conclusions".

15/1 Conclusion 11. "Several lot owners" should be amended to read "Two lot owners". "Our data seem to confirm ground-water intrusion..." is an overstatement. The data are not conclusive. The paragraph is generally vague and the justification for the recommendation that the area needs additional study is not readily verifiable. The inclusion of a recommendation for "additional study" is inconsistent with the labelling of this section as "conclusions".

15/2 Conclusion 12. The horse paddock may be the primary contributor of fecal coliform bacteria at stream sampling station SS-4.

15/3 Conclusion 13. Craig Creek is undefined. This conclusion and conclusion 9 are redundant and should be combined. "Numerous systems" is vague.

15/4 Conclusion 14. Only one well on Lot 25 Block 4, Valli Vue subdivision has shallow ground water. The name of the subdivision was omitted from this paragraph.

16/1 Conclusion 14 (continued). This is a recommendation, and should not be included in the "Conclusions" section.

16/2 The inclusion of Rock Hill Subdivision in the study area should be addressed at the beginning of the report. The rationale behind work in this area is not clear.

16/3 Conclusion 16. "Elevated" NO_3-N concentrations is vague. A more detailed treatment of these data is appropriate.

16/4 What does this mean? Is the "surface water" a creek with a name?

16/6 Conclusion 19. The initial sentence is well supported by data. The data also indicate that 3 or 4 wells may be insufficient to define the water table beneath a septic system, and that inference of a planar water table may be misleading. The flow system concept described in this paragraph appears to be dominantly two-dimensional, instead of a more-appropriate three-dimensional concept. The only method for determining the position of the water table in this area beneath an active drainfield may be to drill a properly constructed well through the drainfield, or at an angle immediately adjacent to the drainfield so that it intercepts the water table beneath the drainfield. The recommendation to install 3 wells is inconsistent with the labelling of this section as "conclusions".

18-23/all Recommendations. This section of the report seems to have an objective of identifying contaminated groundwater and "failed" septic systems in certain subdivisions through drilling of additional wells and preparation of a water-table map. Data contained in this report show that the variability of the position of the water table over short distances is great enough to cause substantial errors in identifying drainfield-water table separation distances. The water table map is unlikely to be of sufficient accuracy to allow it to be used for site-specific evaluations with confidence.

The procedure of combining water-level measurements from different time periods to produce a composite "high water level" water table map is not a standard hydrogeologic practice. A "high water level" period of time could be selected, and all measurements made during that time could be contoured.

The proposal to "adjust" water-level data with climatological data is inappropriate because climatological data are not reliable indicators of water table position. A variety of factors, including depth to the water table, soil composition and moisture conditions, timing and duration of precipitation and snowmelt events, local precipitation patterns, vegetation state, and septic system loading rates all affect water-table fluctuations.

The recommendations section does not adequately address the criteria by which specific properties are targeted for detailed evaluation.

For example, existing data indicate that Audubon Hills subdivision has shallow ground water comparable to other listed subdivisions, yet this subdivision is not targeted for further work. The possible existence of high water conditions under other properties near the listed subdivisions is also not considered. This situation creates the appearance of a substantially biased investigation. This problem is a result of a lack of clearly defined objectives.

The comparison of mapped water table contours with standpipe levels (as described on page 21) to indicate drainfield-water table separation distances is a seriously flawed procedure. The contour map would be based on less detailed information, for any given lot, than is available for the 12 lots equipped with two-three monitoring wells each during the present study. As previously noted by Hart Crowser and this review, even such detailed data is commonly insufficient to determine drainfield-water table separation distances with accuracy and confidence.

The recommendations section of the report neglects the evaluation of surface sources of contamination and movement.

Figure	Comment
B-10	Calculation of fecal coliform/fecal streptococci ratios that are "not suggested to be used" is inappropriate.

C-8,C-11,	The cross section is inconsistent with the drilling log and casing installation report for well no. 24.
C-5,F-2	Well no. 34 showed a 7-ft water level decline from the time of drilling to 21 days later, suggesting that the well may be a conduit for drainage of shallow ground water to a slightly deeper strata or bedrock.
C-35,C-37,F-2	Similar situation as described above.
C-43,F-1	Similar situation as described above.
C-53,F-1	Similar situation as described above.
C-65,F-2	Similar situation as described above.
C-67,F-2	Similar situation as described above.
C-71,F-2	Well no. 27 states "water level @ 7' ATD" and "No free water observed ATD". Which is correct? Possible similar situation as described above.
C-73	Well no. 28 states "Water level @ 8' ATD" and "No free water observed ATD". Which is correct?

References

Canter, L.W., and Knox, R.C., 1985, Septic tank system effects on ground water quality: Lewis Publishers, Inc., Chelsea, Michigan, 336 p.

Hart Crowser, Inc., 1987, Investigative study for determining pollution of surface and subsurface water by on-site septic systems: Unpublished report for the Municipality of Anchorage, Department of Health and Human Services, 24 p., plus appendices.

R&M Consultants, Inc., 1986, Anchorage shallow groundwater monitoring well site selection study: Unpublished report for the Municipality of Anchorage Health and Human Services Department, 21 p., plus tables, figures, and appendix.

U.S. Environmental Protection Agency, 1978, Microbiological methods for monitoring the environment, water and wastes: Cincinnati, Ohio, U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory report EPA-600/8-78-017, 338 p.

APPENDIX A

Municipality of Anchorage

P.O. BOX 6650
ANCHORAGE, ALASKA 99502-0650
(907) 264-6718

TONY KNOWLES, MAYOR

DEPARTMENT OF HEALTH & HUMAN SERVICES
Office of the Director
825 "L" Street

March 24, 1987

RECEIVED
MAR 25 1987
Div. of Geological Survey
Eagle River

Dr. William Long
Section Chief
Water Resources Section
State of Alaska, DGGS -
Department of Natural Resources
P.O. Box 77-2116
Eagle River, Alaska 99577-2116

As you may be aware, the Municipality of Anchorage has recently completed a study entitled Pollution of Surface and Subsurface Water by On-Site Septic Systems. The study was done by Hart Crowser Engineering firm here in Anchorage.

Mary Frohne, a Hillside resident, has spoken to you about the study and indicates you are willing to review it and give us comments on what we can or cannot learn from the report. We invite you to look at it and give us your views. I am sure they will be most helpful. Upon completion I would invite you to meet with our staff for a question and answer period.

Sincerely,

Jewel Jones, Director
Department of Health and
Human Services

JJ2/1/dJ1

cc: Lee Browning
Gus Andress
Mary Frohne

APPENDIX B

STATE OF ALASKA

BILL SHEFFIELD, GOVERNOR

DEPARTMENT OF NATURAL RESOURCES

DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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March 25, 1986

Keith Bandt
Municipality of Anchorage
Dept. of Health & Human Services
P.O Box 6650
Anchorage, AK 99502

Dear Mr. Bandt:

You recently requested our agency's participation in reviewing your program of monitoring shallow groundwater systems in Anchorage. I have reviewed a preliminary draft of a report by R&M Consultants, Inc., entitled "Shallow Groundwater Monitoring Well Site Selection Study", prepared for your department. A copy of that report with margin comments is attached.

In general, I found the report to be an excellent synthesis of a diversity of existing data sources. Automated data manipulation methods are used with logical definition of important parameter groupings, and the resulting maps represent a thorough presentation of shallow hydrogeologic and development conditions in Anchorage. The maps are likely to be of great value in your study.

My concern at this time is that your study is not progressing along a technically logical line of reasoning, and that serious criticism of the study may result at a later date. My perception is that the original mandate of your study was to address the two-part question: "Is some groundwater in Anchorage contaminated by septic system effluent, and if so, how extensive is the contamination?" Several lines of evidence have suggested that some Anchorage groundwater is contaminated and that we may suppose, at least for the present, that the answer to the first part of the question is "yes". Thus, an assessment of the extent of groundwater contamination becomes the focus of the investigation.

I don't believe that the monitoring well program outlined by R&M will result in a detailed resolution of the extent of groundwater contamination. Although their work is sound, it represents a relatively low-budget methodology for site selection that does not adequately consider local variations of geological and hydrological conditions in Anchorage. R&M readily admits that their model and map is "limited in accuracy to that of the individual data layers from which it was drawn". I am suggesting that local hydrogeologic variations are the rule, rather than the exception in Anchorage, and that they

are not described in detail in existing maps or data sources, and that they are important enough to merit detailed consideration in designing a groundwater monitoring program. In fact, reliance on a monitoring well program to assess shallow groundwater contamination has the potential to miss more obvious symptoms of contamination. I believe local hydrogeologic variability is an important contributor to the poor correlation demonstrated between last year's monitoring well data and the polygon attributes of R&M's model.

Groundwater in Anchorage that has become contaminated by septic system effluent can follow one of two general flow paths. It can migrate downward towards deeper aquifers as a result of lower groundwater heads with depth, or it can flow laterally a relatively short distance and discharge to the surface as a seep or spring.

Seeps or springs commonly represent shallow groundwater with short flow paths and may provide the best indicators of shallow groundwater contamination. They may also present health risks of interest to your department. My observations in the Hillside area suggest that seeps or springs are fairly common and are not always associated with local slopes greater than 20 percent because of local hydrogeologic variability. I propose that the Municipality carefully consider the advantages of a thorough program of evaluating water quality at recognizable groundwater discharge sites in a systematic way prior to conducting an extensive well drilling program. The design of such a program is beyond the scope of this letter, but I would be happy to discuss it with you at another time.

The likely advantages of a detailed study of springs and seeps are:

1. relative ease and low cost of sampling, compared to a drilled monitoring well;

2. greater density of data regarding shallow water-quality characteristics, resulting in a better assessment of the extent of contamination;

3. production of a map of all known seep and spring locations for ease of follow-up work or replicate sampling;

4. an assessment of the health implications of seepage or spring water that may be contaminated; and

5. greater precision and reliability in identifying areas where further monitoring-well drilling will yield beneficial results.

You have indicated that the Municipality is embarking on a long-term committment to study the water-quality problem. I heartily support this effort, and am forwarding my comments at this time with the hope that the effort can be placed on as sound a technical footing as possible. I realize that this may cause a conflict with those who may advocate an early start-up of an extensive well-drilling program, but I remind you that water-quality

problems, if they are found to be extensive, have been developing for numerous years and are not likely to be easily or quickly identified and solved.

The publication of a thorough and sound technical report will greatly aid public acceptance of the recommended resolution of the water-quality issue.

Sincerely,

James A. Munter
Hydrogeologist

JAM/jlw

Enclosure