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**TERMS OF REFERENCE:**  
**Determination of Minimum Treatment for**  
**Municipal Residential Drinking Water Systems Using**  
**Subsurface Raw Water Supplies**

**DRAFT, FOR DISCUSSION ONLY**

**PIB #**

*Protecting our environment.*



21 **TERMS OF REFERENCE**  
22 **for**  
23 **Determination of Minimum Treatment for Municipal Residential**  
24 **Drinking Water Systems Using Subsurface Raw Water Supplies**

25 **XXXX 20XX**

26 **1.0 OBJECTIVES**

27 The principal objective of the study defined by these terms of reference and the  
28 accompanying technical support document is ***to determine whether a subsurface***  
29 ***water supply requires treatment beyond a minimum level of disinfection required***  
30 ***to inactivate or remove viruses and bacteria, i.e., whether or not treatment for***  
31 ***protozoa is required.***

32 Treatment requirements are based on raw water quality and, where appropriate, the  
33 precautionary principle. All wells require a minimum level of disinfection in order to  
34 inactivate viruses and bacteria which are far more prevalent in the subsurface than  
35 pathogenic protozoa. Minimum disinfection requirements for well-based municipal  
36 residential drinking water supplies in Ontario have been established to protect against  
37 pathogenic viruses and therefore pathogenic bacteria which are more susceptible to  
38 disinfection than viruses.

39 For subsurface supplies, the need for disinfection of protozoan pathogens  
40 *Cryptosporidium* spp. oocysts (*Cryptosporidium*) and *Giardia* spp. cysts (*Giardia*), in  
41 Ontario is based on:

- 42 a) Evidence of *Cryptosporidium* and/or *Giardia* contamination, or  
43 b) Evidence of both fecal contamination and the presence of an adequately sized or  
44 relatively rapid pathway connecting the subsurface and above ground or near  
45 surface areas.

46 Fecal contamination is demonstrated using *Escherichia coli* (*E. coli*). Potential pathways  
47 are demonstrated using the non-fecal metrics photosynthetic pigment-bearing algae and  
48 diatoms (PBADs). A well is deemed vulnerable to contamination by protozoa if it meets  
49 the following assessment criteria:

- 50 a) If *Cryptosporidium* or *Giardia* are detected, OR  
51 b) If the following water quality threshold is met: there are greater than or equal to 4  
52 detections of *E. coli*. during any 12-month running period, AND there are greater

53 than or equal to 2 detections of photosynthetic, pigment-bearing algae and/or  
 54 diatoms (PBADs) at any point in time.

55 Well classification is based on whether or not further disinfection for protozoa is required  
 56 and whether or not particulate removal is required, i.e., by means of chemically-assisted  
 57 filtration (CAF) or equivalent.

58 Particulate removal is required if:

- 59 - Particles in the water could harbor pathogens or otherwise hinder the disinfection  
 60 process.

61 A well is deemed to require particulate removal if it meets the following criterion:

- 62 - If the turbidity ever exceeds 10 NTU in two consecutive samples collected  
 63 continuously and/or the 95<sup>th</sup> percentile is above 5 NTU.

64 The table below provides a guide of updated terms for well classification.

65 *Updated subsurface water terminology*

Source Water Category		Minimum Required Treatment Level	
Existing Term	Updated Term	Overall	Particulate Removal
Groundwater	Category 1	4-log virus or as mandated by the current version of the Procedure for Disinfection of Drinking Water in Ontario	None
Groundwater Under the Direct Influence of Surface Water (GUDI) With Effective Filtration	Category 2	4-log virus 3-log <i>Giardia</i> spp. cysts 2-log <i>Cryptosporidium</i> spp. oocysts or as mandated by the current version of the Procedure for Disinfection of Drinking Water in Ontario	None
GUDI	Category 3		Chemically Assisted Filtration (CAF)
	Category 3E		Approved alternative to CAF

66

67 The categories are described below:

68 **Category 1** wells require minimum disinfection for viruses (4-log or current regulated  
69 minimum requirement as per the Procedure for Disinfection of Drinking Water in  
70 Ontario) that results in concurrent inactivation of bacteria. These wells must reliably  
71 supply source water of high physical and chemical quality. The microbiological water  
72 quality in these wells may indicate minimal fecal contamination or a potential pathway  
73 for protozoa has been demonstrated, but both of these thresholds have not been met.  
74 Protozoan pathogens have never been detected in these wells.

75 **Category 2** wells require minimum disinfection for protozoan pathogens  
76 *Cryptosporidium* (2-log or current regulated minimum requirement) and *Giardia* (3-log or  
77 current regulated minimum requirement), as well as viruses (4-log or current regulated  
78 minimum requirement); resulting in concurrent inactivation of bacteria. These wells must  
79 reliably supply source water of high physical and chemical quality. The microbiological  
80 water quality in these wells may indicate minimal fecal contamination and/or a potential  
81 pathway for protozoa may have been demonstrated. Protozoan pathogens  
82 (*Cryptosporidium* and/or *Giardia*) may have been detected in the wells. Systems may  
83 choose this level of classification even though they may not have met all the  
84 assessment criteria to be deemed vulnerable to contamination by pathogenic protozoa.

85 **Category 3 or 3e** wells require minimum disinfection for protozoan pathogens  
86 *Cryptosporidium* (2-log or current regulated minimum requirement) and *Giardia* (3-log or  
87 current regulated minimum requirement), as well as viruses (4-log or current regulated  
88 minimum requirement); resulting in concurrent inactivation of bacteria. These wells do  
89 not reliably supply source water of high physical and chemical quality, and therefore  
90 require additional treatment beyond disinfection (chemically assisted filtration or  
91 equivalent) to achieve minimum viral and protozoan pathogen treatment requirements.  
92 The microbiological water quality in these wells may indicate minimal fecal  
93 contamination and/or a potential pathway for protozoa may have been demonstrated.  
94 Protozoan pathogens (*Cryptosporidium* and/or *Giardia*) may have been detected in the  
95 wells. Systems may choose this level of classification even though they may not have  
96 met all the assessment criteria to be deemed vulnerable to contamination by pathogenic  
97 protozoa.

## 98 **2.0 GENERAL REQUIREMENTS**

99 Determination of minimum treatment for municipal residential drinking water systems  
100 using subsurface raw water supplies is based on the following:

- 101 - Well integrity and structural assessment (see Section 2.1);
- 102 - Assessment of vulnerability to contamination by protozoa (see Section 2.2);
- 103     o Hydrogeological Study (see Section 2.2.1);

- 104           ○ Operational Confirmation Period (See Section 2.2.2); and
- 105         - Physical and chemical water quality evaluation (See Section 2.3).

106 The results of the study and determination of minimum treatment requirements at the  
107 end of the study or at any time during the operation of a subsurface raw water supply  
108 shall be reported to the ministry as per requirements in Section 3.0.

109 In scoping the study requirements, consideration should be given to whether a well is  
110 new or existing. New wells, existing wells wishing to reclassify, or existing wells where  
111 raw water quality has deteriorated beyond explicitly defined water quality thresholds and  
112 criteria are required to undergo a study as defined by these terms of reference.  
113 Suggested references are included in Section 4.0 and the chart in Section 5.0 provides  
114 a summary of the framework for well classification.

## 115 **2.1 WELL INTEGRITY AND STRUCTURAL ASSESSMENT**

116 When wells are drilled, an annular space is created around the well casing that if  
117 unsealed or improperly sealed may create a potential pathway for protozoa  
118 contamination. Furthermore, casings may fail or be damaged and provide a potential  
119 pathway for protozoan contamination.

120 There has never been a detection of protozoa in untreated water from a well in Ontario.  
121 In North America, the detections of protozoa in untreated well water have been  
122 associated with direct contamination from sewage sources such as leaking sanitary  
123 sewers or from faulty well casings near sources of sewage or agricultural contamination.

124 The purpose of the well integrity and structural assessment is to provide a framework  
125 for evaluating existing wells, to assess the integrity of the annular seal and whether the  
126 well casing is structurally sound. Guidance is provided for both intrusive and non-  
127 intrusive methods to investigate the presence or absence of an annular seal, its  
128 thickness and material composition. It also provides recommended practices for new  
129 well construction. The outcome of the well integrity and structural assessment classifies  
130 the well integrity as either low risk or high risk.

131 All wells should be in compliance with current regulations, including Ontario Regulation  
132 903/90 Wells (O. Reg. 903/90). An infiltration gallery as defined by O. Reg. 170/03 does  
133 not meet the requirements of O. Reg. 903/90 and is classified as either Category 2 or 3.

134 New water supply well owners are strongly encouraged to confirm that their new well is  
135 being constructed in accordance with the guidance provided to classify their well as low  
136 risk. Existing wells may be required to perform well integrity and structural assessment  
137 as described in Section 2.2 and 2.3.

138

139 **2.2 ASSESSMENT OF VULNERABILITY TO CONTAMINATION BY PROTOZOA**

140 An assessment of well vulnerability to contamination by protozoa (AVCP) is completed  
141 to determine if a water supply well is vulnerable to contamination by protozoa.

142 The AVCP is carried out in one or two stages, depending on whether the well is a new  
143 well (Stages 1 and 2) or an existing well (Stage 2 only). The Stage 1 Hydrogeological  
144 Study is further broken down into a preliminary hydrogeological assessment and  
145 pumping test work plan (Part A) and a pumping test (Part B). The Stage 2 Operational  
146 Confirmation Period includes a two year operational monitoring period.

147 An AVCP must be completed for new wells, existing Category 2 or 3 wells wishing to  
148 reclassify to Category 1, or existing Category 1 wells which are following monitoring  
149 requirements of Ontario Regulation 170/03 Drinking Water Systems (O. Reg. 170/03)  
150 and have greater than 4 detections of *E. coli* during any 12-month period.

151 For new well supplies, data collected and evaluated during Stage 1 are used to  
152 determine whether there is a relatively lower or higher potential vulnerability to  
153 contamination by protozoa. Based on that potential vulnerability (i.e., lower or higher),  
154 Stage 2 is respectively carried out using a “baseline” or “enhanced” water quality  
155 monitoring program.

156 Existing wells wishing to reclassify require 4 years of monthly or 2 years of weekly O.  
157 Reg. 170/03 microbiological water quality data prior to commencing the Stage 2.  
158 Existing wells carry out Stage 2 using an “enhanced” water quality monitoring program.  
159 Existing wells with greater than 4 *E. coli* detections in a running 12-month period are  
160 required to perform a well integrity and structural assessment and correct any  
161 deficiencies to ensure that the well integrity is low risk prior to the enhanced Stage 2  
162 AVCP or provide treatment for protozoa.

163 Determination regarding vulnerability to contamination by protozoa is made at any time  
164 the assessment criteria are met or at the conclusion of Stage 2, whichever occurs first.  
165 Reporting is then completed to bring the AVCP to a close. If a well is deemed  
166 vulnerable to contamination by protozoa, a physical and chemical water quality  
167 evaluation is completed to determine the need for CAF or equivalent. If at any time  
168 during the Stage 2 the turbidity criterion is met, the Stage 2 shall be terminated and the  
169 physical and chemical water quality evaluation completed.

170 In addition to these requirements, if at any time during the operation of a Category 1  
171 well *E. coli* is detected during O. Reg. 170/03 monitoring, a sample shall be taken and  
172 tested for *Cryptosporidium* and *Giardia* within 24 hours and a resample of *E. coli*. Also,

173 if the assessment criteria are met at any time during the operation of a Category 1 well,  
174 the well is deemed vulnerable to contamination by protozoa and the ministry shall be  
175 notified.

### 176 **2.2.1 AVCP Stage 1 Hydrogeological Study**

177 The AVCP Stage 1 Hydrogeological Study is completed for new wells. It is broken down  
178 into a Part A and Part B. If after the end of the Stage 1 the assessment criteria have not  
179 been met, the well can be classified as Provisional Category 1 with either “lower” or  
180 “higher” potential vulnerability to contamination by protozoa and continue to the Stage 2  
181 AVCP. A well is deemed to have a “higher” potential vulnerability to contamination by  
182 protozoa if:

- 183 - Evidence of preferential pathway(s);
- 184 - Water table drawdown caused by supply well pumping; or
- 185 - Temperature, turbidity and conductivity fluctuations greater than 20 % indicating  
186 surface connectivity.

### 187 ***Part A Preliminary Hydrogeological Evaluation and Pumping Test Work Plan***

188 Part A consists of a preliminary hydrogeological evaluation and pumping test work plan.  
189 The goal of Part A is to obtain an understanding of the hydrogeological setting of the  
190 production well (or proposed production well), which will then allow the collection of a  
191 reliable and sufficient set of water quality data from the well. The assessment should be  
192 prepared under the supervision of a licensed Professional Geoscientist, or exempted  
193 Professional Engineer, who is qualified to prepare a hydrogeological assessment, as set  
194 out in the Professional Geoscientists Act of Ontario. The practitioner may design an  
195 efficient study to make use of any existing data and, if relevant, to simultaneously collect  
196 data to support the requirements of the physical and chemical water quality  
197 assessment. The AVCP Stage 1 Part A should include:

#### 198 *Preliminary Hydrogeological Evaluation*

- 199 1. Information review of the study area, including the following:
  - 200 i. Previous hydrogeological assessments,
  - 201 ii. Topography,
  - 202 iii. Local and regional quaternary geology,
  - 203 iv. Local and regional bedrock geology,
  - 204 v. Local and regional hydrogeology,
  - 205 vi. Historical groundwater quality data,
  - 206 vii. Historical water level data, and
  - 207 viii. Travel time prediction;

- 208 2. Site visit and surface water catchment area delineation;  
209 3. Preferential pathways assessment;  
210 4. Groundwater vulnerability mapping;  
211 5. Potential sources of fecal contamination;  
212 6. Part A summary report including the hydrogeological conceptual model for the supply  
213 well and the aquifer; and

214 Pumping Test Work Plan

- 215 7. Work plan for Stage 1 Part B, with details about the proposed pumping test.

216 **Part B Pumping Test Evaluation**

217 The pumping test shall be performed at the expected maximum pumping rate. As a  
218 minimum, a 72-hour test is required—this does not consider any Permit To Take Water  
219 (PTTW) requirements for the length of the pumping test. If the length of the pumping  
220 test is increased to meet conditions of the PTTW, consideration should be given to  
221 collecting additional data to provide additional confidence regarding the AVCP.

222 72-Hour Pumping Test

223 The 72-Hour Pumping Test is conducted to collect:

- 224 • Key water quality data that can be used to inform water well supply vulnerability to  
225 contamination by protozoa under conditions as similar as possible to the  
226 anticipated well production conditions, and  
227 • Hydrogeological data to confirm the setting and conceptual model of the aquifer  
228 and well, and to plan for data collection requirements during any operational  
229 confirmation period for the well.

230 The following provides the minimum requirements of the pumping test evaluation:

- 231 1. Monitoring locations;  
232 2. Continuous water level monitoring;  
233 3. Meteorological data;  
234 4. Water sampling from pumping well, including:  
235 i. At least five (5) samples for *E. coli*, including one (1) sample at the end of the  
236 pumping test, to assess trends or changing water quality during pumping,  
237 ii. At least three (3) samples for general chemistry (i.e., major anions/cations,  
238 alkalinity or bicarbonate, and dissolved organic carbon), including one (1)  
239 sample at the end of the pumping test,



- 240       iii. Dissolved oxygen (DO), temperature, conductivity, and pH measured in the field  
241           when the general chemistry samples are collected, and  
242       iv. At least two (2) samples for *Cryptosporidium*, *Giardia*, and PBADs, including one  
243           (1) sample collected within the last 24 hours of the pumping test;
- 244   5. Pumping rates and volumes with continuous pumping rate data (15 min. intervals);  
245   6. Design parameter monitoring at pumping well:
- 246       v. Continuous turbidity measurements (15 min. intervals),  
247       vi. Continuous UV transmittance (UVT) measurements (hourly min. intervals), and  
248       vii. A chlorine demand test at the end of the pumping test;
- 249   7. Water sampling from monitoring wells;  
250   8. Water sampling from surface water;  
251   9. Additional analyses at the discretion of the proponent.

## 252   **2.2.2 AVCP Stage 2 Operational Confirmation Period**

253   The AVCP Stage 2 Operational Confirmation Period consists of a two year water quality  
254   monitoring program. This stage applies to new supply wells categorized as Provisional  
255   Category 1, existing water supply wells wishing to reclassify with sufficient historical  
256   water quality data or existing wells with greater than 4 *E. coli* detections in any 12-  
257   month period.

258   The purpose of the Stage 2 monitoring is to determine the vulnerability to contamination  
259   by protozoa at typical operating conditions and varying climatic conditions, including  
260   significant recharge events. The duration of the Stage 2 period is 24 consecutive  
261   months of normal well operation (unless a determination can be made and it can be  
262   terminated early, as indicated below).

263   Data collected and evaluated for new wells during Stage 1 are used to determine  
264   whether there is a relatively lower or higher potential vulnerability to contamination by  
265   protozoa. Based on that potential vulnerability (i.e., lower or higher), Stage 2 is  
266   respectively carried out using a “baseline” or “enhanced” water quality monitoring  
267   program. The monitoring programs are detailed in the table below. Existing wells shall  
268   complete the enhanced program.

269   Stage 2 of the AVCP is carried out using a “baseline” water quality monitoring program  
270   for all wells with low potential vulnerability to contamination by protozoa, as concluded  
271   in the Stage 1 AVCP report. If either:

- 272       • 2 or 3 detections of *E. coli* in a running year, OR  
273       • 2 detections of PBADs

274 are detected during Stage 2 AVCP “Baseline” monitoring, the remainder of the Stage 2  
 275 AVCP must be carried out using an “enhanced” water quality monitoring program.

276 *"Baseline" and "Enhanced" Water Quality Monitoring Requirements during Stage 2*  
 277 *AVCP Operational Confirmation Period*

Item	Baseline Monitoring Program	Enhanced Monitoring Program
1. Supply Well	Continuous turbidity measurements (15 min intervals)	Continuous turbidity measurements (15 min intervals)
2. Supply Well	Weekly raw water samples for <i>E. coli</i>	Weekly raw water samples for <i>E. coli</i>
3. Supply Well	Three (3) samples per year for <i>Giardia</i> spp. cysts, <i>Cryptosporidium</i> spp. oocysts, and photosynthetic pigment-bearing algae and/or diatoms (PBADs) <sup>1</sup> . Samples should be collected at least 3 months apart and in the following periods: fall, spring recharge, and summer.	Monthly, i.e. twelve (12) samples per year for <i>Giardia</i> spp. cysts, <i>Cryptosporidium</i> spp. oocysts, and PBADs <sup>1</sup> .
4. Wellfield	Pumping rates and water level measurements. Surface water drainage assessment.	Pumping rates and water level measurements. Surface water drainage assessment.

<sup>1</sup> *Sampling for these parameters may be discontinued once a potential pathway that is rapid and adequately large for protozoa or similar-sized particles to migrate into the well from above ground or the near surface has been confirmed (i.e., once there are 2 detections of PBADs).*

278 If at any time during the Stage 2 the turbidity criterion for Category 3 treatment is met,  
 279 Stage 2 of the AVCP shall be terminated and the physical and chemical water quality  
 280 assessment should be conducted. A minimum of three (3) months of online (continuous)  
 281 turbidity data is required to make the assessment. Other considerations include:

- 282 1. Pumping rates and volumes

- 283 2. Continuous water level monitoring
- 284 3. Meteorological data
- 285 4. Surface water drainage

286 **2.3 DETERMINATION OF NEED FOR CHEMICALLY ASSISTED FILTRATION**

287 Once a well is deemed vulnerable to contamination by protozoa, the well will need to be  
288 classified as a Category 2 or 3 water supply. To achieve targeted levels of disinfection  
289 of viruses and protozoa, disinfection processes require sufficiently high physical and  
290 chemical water quality. Final classification and associated treatment requirements are  
291 determined based on physical and chemical water quality evaluation.

292 If the turbidity never exceeds 10 NTU in two consecutive samples collected  
293 continuously and the 95<sup>th</sup> percentile is below 5 NTU, the well is classified as Category 2.  
294 Otherwise, it is classified as Category 3 or Category 3e. A minimum of three months of  
295 continuous (15 min. interval) data is required to make the determination. For systems  
296 owners wishing to reclassify their wells from Category 3 to Category 2, 2 years of  
297 continuous online data is required prior to reclassification.

298 Dissolved organic carbon concentrations (DOC) and ultraviolet light transmittance at  
299 254 nm (UVT) are also critical parameters evaluated to determine treatment  
300 requirements. The DOC is a measure of the natural organic matter in the water that may  
301 be available to react with disinfectants to create disinfection by-products, some of which  
302 are regulated. The DOC may also affect other treatment processes and the biological  
303 stability of the treated water in the distribution system. If DOC is above 2 mg/L it is  
304 recommended to assess DBP formation potential and consider alternative chemical  
305 disinfectants. The UVT is an important parameter in the design of ultraviolet light  
306 disinfection systems, and minimum UVT requirements will be dependent on the chosen  
307 UV reactor. UVT may also be used as a surrogate for disinfection by-product formation  
308 potential.

309 **3.0 PREPARATON AND SUBMISSION OF REPORTS**

310 *ACVP Stage 1 Report*

311 A report should be prepared at the end of the Stage 1 AVCP. This is completed after the  
312 Stage 1 Part B pumping test evaluation or concurrently as the Stage 1 Part A  
313 Preliminary Hydrogeological Evaluation Summary Report if it concludes that the Part B  
314 evaluation (72-hour pump test) is not required. The report should include all sampling  
315 data results collected as part of the assessment criteria to determine if the well is  
316 vulnerable to contamination by protozoa (i.e. *Giardia*, *Cryptosporidium*, PBADs or *E.*  
317 *coli*). If vulnerable, it is recommended that the well be classified as a Category 2 or 3  
318 Water Supply, with final classification and associated treatment requirements

319 determined based on the physical and chemical water quality evaluation. If the  
320 assessment criteria have not been met, it should be recommended that the well be  
321 categorized as Provisional Category 1 and it should be concluded that further testing is  
322 required through a Stage 2 Operational Confirmation Period. In this case, the report  
323 must conclude if the potential for well contamination by protozoa is “lower” or “higher”  
324 and respectively, which monitoring program must be implemented during the Stage 2  
325 period: “Baseline” or “Enhanced”. All lines of evidence leading to this conclusion should  
326 be clearly stated and summarized.

327 In addition to the above, the Stage 1 Report should include the following components:

- 328 i. A statement of the objectives of the assessment.
- 329 ii. A description of the Study Area.
- 330 iii. A methods section providing an overview of the work performed and the  
331 details on the methodologies used, including potential limitations and  
332 assumptions. This includes a discussion on the adequacy of groundwater  
333 monitoring locations and should reference and append the Part B work plan.  
334 The report should include a description and rationale for any modifications  
335 made to the Part B work plan.
- 336 iv. Summary of well integrity and structural assessment, if applicable.
- 337 v. Description of the local and regional geologic and hydrogeological setting of  
338 the well. This should reference and update the Stage 1 Part A summary report  
339 findings. The Stage 1 Part A report should be provided in an appendix of the  
340 report.
- 341 vi. Hydrogeological cross-section(s) with geology, borehole locations and water  
342 level measurements. The borehole/well logs should be provided in an  
343 appendix of the report.
- 344 vii. Updated discussion and mapping of groundwater vulnerability, preferential  
345 pathways, and the inventory of potential fecal sources- based on the Stage 1  
346 Part A summary report and incorporating any new information from the Part B  
347 study.
- 348 viii. Evaluation of the surface water drainage, including a discussion of potential for  
349 seasonal or temporary drainage changes (e.g., water ponding or ephemeral  
350 streams near the water supply wells).
- 351 ix. An assessment of all relevant microbial groundwater quality data from the  
352 supply well and other nearby wells in the same aquifer, including all available  
353 *E. coli*, *Cryptosporidium*, *Giardia*, and PBAD data. Sampling and analytical  
354 methods should be referenced and any limitations discussed.

355 Pumping test interpretation must include:

- 356 i. Hydraulic properties (transmissivity or hydraulic conductivity, leakage factors,  
357 and storage coefficient or storativity) of the relevant units and a discussion

- 358 with respect to aquifer type and classification (i.e., confined, semi-confined,  
359 or unconfined).
- 360 ii. An assessment of the hydraulic connectivity of the pumped aquifer to near  
361 surface. The assessment should include a discussion of hydraulic responses  
362 to precipitation and recharge events within both the shallow and deeper  
363 supply aquifer, and if changes in vertical gradients are evident beneath  
364 surface water features or within the shallow aquifer under pumping  
365 conditions.
- 366 iii. Evaluation of groundwater quality data (laboratory, field, and online  
367 parameters), including trends or changing water quality during pumping, and  
368 comparison of the supply aquifer to shallow groundwater and to surface  
369 water quality.
- 370 iv. Review of available water level data to determine potential responses to  
371 precipitation or infiltration events and evaluate the relationships between  
372 variable climatic conditions and transient characteristics of the aquifer system  
373 (hydraulic connectivity, time lag) to provide an indication of the potential for  
374 water quality to vary during climatic events.
- 375 v. Summary and assessment of any additional field work completed including  
376 conclusions related to the objectives of the study.
- 377 vi. All supporting tabulated data, maps, graphs and photographs.

378 ACVP Stage 2 Report

379 The Stage 2 report must include conclusions on the vulnerability to contamination by  
380 protozoa based on the assessment criteria. If vulnerable, it is recommended that the  
381 well be classified as a Category 2 or 3 Water Supply, with final classification and  
382 associated treatment requirements determined based on the physical and chemical  
383 water quality evaluation. In the case that the water quality thresholds for only PBADs or  
384 *E.coli* are exceeded, the well is deemed not vulnerable to contamination by protozoa,  
385 but requires continued surveillance of well water quality. It should be recommended that  
386 the well be (or remain) categorized as Category 1, with final classification and  
387 associated treatment requirements determined based on the physical and chemical  
388 water quality evaluation. Accordingly, it is required that, for the purposes of due  
389 diligence, another Stage 2 Operational Confirmation Period should commence without  
390 interruption, and with enhanced monitoring. It is possible that in cases of long-term,  
391 persistent fecal contamination, a system might be continuously required to assess  
392 vulnerability to contamination by protozoa. System owners are encouraged to consider  
393 providing Category 2 or 3 treatment in such cases, with additional treatment  
394 requirements determined based on physical and chemical water quality evaluation.

395 Otherwise, it is deemed not vulnerable to contamination by protozoa and it should be  
396 recommended that the well be (or remain) categorized as Category 1, with final  
397 classification and associated treatment requirements determined based on physical and  
398 chemical water quality evaluation.

399 The Stage 2 report must also include:

- 400 i. A statement of the objectives of the assessment.
- 401 ii. A description of the Study Area.
- 402 iii. A methods section providing an overview of the work performed and the  
403 details on the methodologies used, including potential limitations and  
404 assumptions.
- 405 iv. Summary of any well integrity and structural assessment performed during  
406 the Stage 2 period, if applicable.
- 407 v. References to the Stage 1 reports, if applicable.
- 408 vi. Copies of Laboratory Reports for water quality monitoring (as a digital  
409 appendix).
- 410 vii. Summaries of water level and climatic monitoring data.

411

#### 412 **4.0 SUGGESTED REFERENCES**

413

414 “Terms of Reference – Hydrogeological Study to Examine Groundwater Sources  
415 Potentially under the Direct Influence of Surface Water” (2001).

416 Ontario Regulation 170/03 “Drinking Water Systems” made under the Safe Drinking  
417 Water Act (2002).

418 Ontario Regulation 903/90 “Wells” made under the Ontario Water Resources Act  
419 (1990).

420 “Procedure for Disinfection of Drinking Water in Ontario” (2006).

421 “Technical Support Document for Determination of Minimum Treatment for Municipal  
422 Residential Drinking Water Systems Using Subsurface Raw Water Supplies” (20xx).

423 “Technical Rules: Assessment Report”, *Clean Water Act 2006*, November 16, 2009.

#### 424 **5.0 SUMMARY**

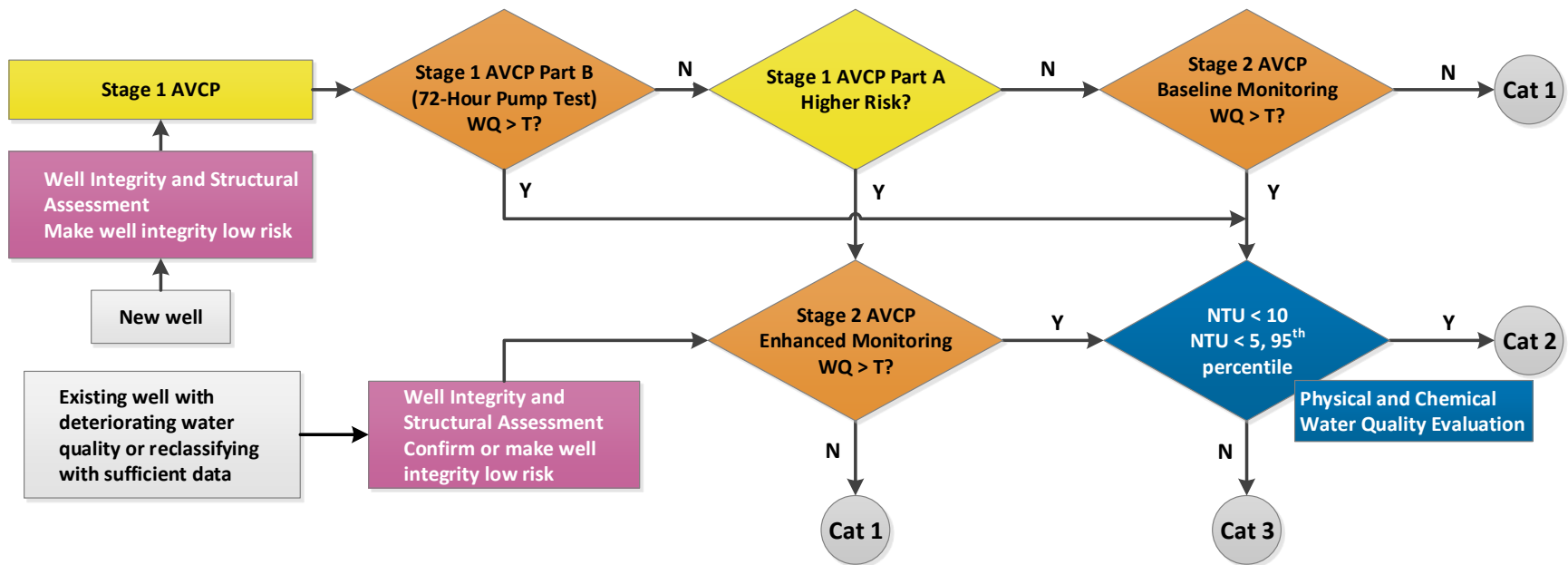
425

426 The principal objective of the study defined by these terms of reference and the  
427 accompanying technical support document is ***to determine whether a subsurface  
428 water supply requires treatment beyond a minimum level of disinfection required  
429 to inactivate or remove viruses and bacteria, i.e., whether or not treatment for  
430 protozoa is required.*** Well classification is based on whether or not further disinfection  
431 for protozoa is required and whether or not particulate removal is required, i.e., by  
432 means of chemically-assisted filtration (CAF) or equivalent.

433 A study must be completed for new wells, existing wells wishing to reclassify, or existing  
434 Category 1 wells which are following monitoring requirements of O. Reg. 170/03 and

435 have greater than 4 detections of fecal indicators during any 12-month period.  
436 Components of the study may include well integrity and structural assessment,  
437 assessment of vulnerability to contamination by protozoa and/or physical and chemical  
438 water quality evaluation. The chart below provides a summary of the framework for well  
439 classification.

440 The results of the study and determination of minimum treatment requirements of a  
441 subsurface raw water supply shall be reported to the ministry.



Item	Baseline Monitoring Program	Enhanced Monitoring Program
1. Supply Well	Continuous turbidity measurements (15 min intervals)	Continuous turbidity measurements (15 min intervals)
2. Supply Well	Weekly raw water samples for <i>E. coli</i>	Weekly raw water samples for <i>E. coli</i>
3. Supply Well	Three (3) samples per year for <i>Crypto</i> , <i>Giardia</i> , and PBADs <sup>1</sup> , taken at least 3 months apart (in fall, spring recharge, and summer).	Monthly, i.e. twelve (12) samples per year for <i>Crypto</i> , <i>Giardia</i> and PBADs <sup>1</sup> .
4. Wellfield	Pumping rates and water level measurements. Surface Water drainage assessment.	Pumping rates and water level measurements. Surface Water drainage assessment.
1: Discontinued sampling once there are 2 detections of PBADs.		

**Legend**

AVCP – Assessments of vulnerability to contamination by protozoa  
 NTU – Nephelometric turbidity units  
 PBADs – Photosynthetic pigment bearing algae and/or diatoms  
*Crypto* – *Cryptosporidium* spp. oocysts  
*Giardia* – *Giardia* spp. cysts  
*E. coli* – *Escherichia coli*  
 WQ > T – Water quality threshold  $\geq 4$  *E. coli* +  $\geq 2$  PBADs OR any *Giardia* or *Cryptosporidium* detected  
 PFD – Procedure for Disinfection of Drinking Water in Ontario  
 CAF – Chemically Assisted Filtration  
 Cat 1 – Category 1, disinfection to achieve treatment levels for groundwater as per PFD.  
 Cat 2 – Category 2, disinfection to achieve treatment levels for surface water as per PFD. No particulate removal required.  
 Cat 3 – Category 3, disinfection to achieve treatment levels for surface water as per PFD. CAF or equivalent required.