Enbridge Energy, Limited Partnership
1601 Pratt Avenue
Marshall, Michigan 49068

May 18, 2012

Mr. Ralph Dollhopf
Federal On-Scene Coordinator and Incident Commander
U.S. Environmental Protection Agency
801 Garfield Avenue, #229
Traverse City, MI 49686

Re: In the Matter of Enbridge Energy Partners, L.P., *et al*,
Docket No. CWA 1321-5-10-001

Dear Mr. Dollhopf:

The United States Environmental Protection Agency (U.S. EPA) in a letter dated May 11, 2012, gave Enbridge Energy, Limited Partnership (Enbridge) Notice of Approval with Modifications of the Report of Findings for Submerged Oil Temperature Effects Study dated April 5, 2012. The U.S. EPA provided comments with the notice of approval with modifications and established a due date of May 18, 2012 for resubmittal.

Enclosed, please find the Approved Report of Findings for Submerged Oil Temperature Effects Study dated May 18, 2012 along with a response to comments log for your convenience.

If you have any questions about these materials, please do not hesitate to contact me.

Sincerely,

ENBRIDGE ENERGY, LIMITED PARTNERSHIP
By Enbridge Pipelines (Lakehead) L.L.C.
Its General Partner

Richard Adams
Vice President, U.S. Operations

CC: John Sobojinski, Enbridge
Bob Steede, Enbridge
Sonia Vega, EPA Region 5
Mark DuCharme, MDEQ
Michelle DeLong, MDEQ

RESPONSE TO COMMENTS LOG

Re: Approval, with Modifications, of Enbridge Energy, Limited Partnership's April 5, 2012 Submittal in response to the Administrative Order issued by U.S. EPA on July 27, 2010 and Supplement to the Administrative Order issued by U.S. EPA on September 23, 2010, pursuant to §311(c) of the Clean Water Act (Docket No. CWA 1321-5-10-001)

The United States Environmental Protection Agency (U.S. EPA) has completed its review of the following document submitted by Enbridge Energy, Limited Partnership, Enbridge Pipelines (Lakehead) L.L.C., Enbridge Pipelines (Wisconsin), and Enbridge Energy Partners, L.P. (herein collectively referred to as "Enbridge"):

Enbridge Line 6B MP 608, Marshall, MI Pipeline Release, Report of Findings for Submerged Oil Temperature Effects Study, Prepared for United States Environmental Protection Agency, Enbridge Energy, Limited Partnership, Originally Submitted: February 20, 2012, Resubmitted: April 5, 2012

Pursuant to Paragraph 18 of the July 27, 2010 Order, U.S. EPA approves, with modifications, Enbridge's above-referenced *Report of Findings for Submerged Oil Temperature Effects Study (ROFTEMS),* including attachments, submitted to U.S. EPA on April 5, 2012. Enbridge shall incorporate the comments below into a revised *ROFTEMS.*

1. Section 2.2.2: Please provide a formal citation for the referenced U.S. EPA-approved poling method.

   Response: The following reference was added to Section 2.2, "Poling was conducted per the *Supplement to the Response Plan for Downstream Impacted Areas and the Source Area Response Plan Commonly Referred to as the "Overbank and Poling Reassessment Work Plan"* (Enbridge, 2011c) approved by the U.S. EPA on April 15, 2011."

2. Section 3.2.2: The U.S. EPA-approved work plan for the Temperature Effects Monitoring Study *(TEMS)* specifies that the number of globules observed following each agitation/treatment step should be recorded. Please provide a reference indicating that, during execution of the *TEMS,* Enbridge decided that a more accurate quantification of globules was possible using area of globule and percent of area of globule, rather than the number of globules.

   Response: The following text was added to explain the use of area instead of quantity in Section 3.2.1, "It was determined during the process of the test that presenting globules as a percentage of total area better quantifies the amount of oil globules liberated. For example, reporting in graphical format five small globules being greater than two numerically may not accurately portray that the size of the two may be larger than all five small globules combined. The percent coverage of globules (accurately captured using the transparency sheets, digitized, and calculated within the GIS system) creates a more accurate amount of oil globule to present."

3. Attachment A: Please add numeric temperatures on the vertical axis (i.e., "Y" axis) of the graph entitled Historic Daily Water and Sediment Temperatures.

   Response: Temperature was added to the y-axis as requested.

Enbridge Line 6B MP 608
Marshall, MI Pipeline Release

Report of Findings for Submerged Oil Temperature Effects Study

Prepared for United States Environmental Protection Agency

Enbridge Energy, Limited Partnership

Originally Submitted: February 20, 2012

Resubmitted: April 5, 2012

Approved: May 18, 2012

Table of Contents

FIGURES

TABLES

ATTACHMENTS

LIST OF ACRONYMS

Bench Study	Temperature Effects Bench Study
DRO	Diesel Range Organics
GIS	Geographic Information System
LDB	left descending bank
mg/kg	Milligrams per killigram
mL	Milliliter
MP	Mile Post
ORO	Oil Range Organics
SOPs	Standard operating procedures
TEMS	Temperature Effects Monitoring Station
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
U.S. EPA	United States Environmental Protection Agency
UV	ultraviolet

1.0 Introduction

The activities detailed in this report were completed in general accordance with the sediment sampling standard operating procedures (SOPs) presented in the approved *Sampling and Analysis Plan* as amended (Enbridge, 2011a) particularly *Section 6.3.2* (entitled "Ponar® or Ekman Dredge Sampling") found in *SOP EN-202* and *Section 4.4* of the *Addendum to the Response Plan for Downstream Impacted Areas, August 2, 2010 (Revised August 17, 2010 per U.S. EPA August 17, 2010 letter), Supplement to Source Area Response Plan, and Supplement to Response Plan for Downstream Impacted Areas, Referred to as Operations and Maintenance Work Plan Commonly referred to as "Consolidated Work Plan from Fall 2011 through Fall 2012"* approved by the United States Environmental Protection Agency (U.S. EPA) on December 21, 2011 (Enbridge, 2011b). In accordance with the aforementioned work plan, the study was implemented to evaluate the effect of temperature on the relative occurrence of oil/sheen on the water surface upon agitation of sediment at various temperatures. The purpose of this report is to present the results of this study of temperature effects on submerged oil to enhance the understanding of the effects that water and sediment temperatures have on submerged oil liberation and the implications for subsequent effectiveness of recovery methods.

1.1 Objective

The objective of the Temperature Effect Monitoring Station (TEMS) Study and the Temperature Effects Bench Study (Bench Study) is to assess the relationship between liberation of submerged oil from sediment as a function of water temperature. The oil contaminated sediment behavior was observed at the following target temperatures:

- The TEMS study, completed within the Kalamazoo River itself, was completed at a sediment and water temperature range of approximately 43 °F to 60 °F.
- The Bench Study, completed within a lab controlled environment, was completed at sediment and water temperatures of approximately 35 °F, 45 °F, 55 °F, 65 °F, and 75 °F.

The evaluation and conclusions of the temperature effect studies are relative to observations at other temperatures.

2.0 Study Procedures

The TEMS study was conducted in October 2011 and the Bench Study was started in December 2011, with the original scope of work being completed in early January 2012. During both tests, appropriate health and safety procedures were followed in accordance with the *Health and Safety Plan* (Enbridge, 2012) approved on April 19, 2012 and any approved applicable guidance. The U.S. EPA observers provided oversight for the entire testing process.

2.1 Historical Water and Sediment Temperatures

Water and sediment temperatures have been methodically collected and reported daily for the project since April 1, 2011. Temperature readings are collected at ten locations and averaged to produce a graph illustrating the daily average water and sediment temperatures on the river. A graph illustrating these daily averages since April 1, 2011 is included in *Attachment A.*

2.2 TEMS Study Methods/Procedures

Nine 3-foot by 3-foot TEMS were installed within the focus areas of 36.45 North and 36.50T (*Figure 1*). These two focus areas were selected because recovery operations were not performed in these areas in 2011 and therefore represent fairly undisturbed areas of impacted sediment. The structure locations were selected to include a range of previously classified water surface observations of submerged oil (following agitation of streambed sediment), ranging from light to heavy presence of sheen and globules as illustrated in *Attachment B*. The nine TEMS locations are presented on *Figure 1*. Each station was designed, constructed, and installed to provide containment for a 3-foot by 3-foot area extending from above the water surface down to (or through) the upper layer(s) of the bed material. This allowed for temperature monitoring and poling to be conducted in a semi-controlled environment. Poling was conducted per the *Supplement to the Response Plan for Downstream Impacted Areas and the Source Area Response Plan Commonly Referred to as the "Overbank and Poling Reassessment Work Plan"* (Enbridge, 2011c) approved by the U.S. EPA on April 15, 2011. Poling methods involved agitation of the near surface sediment with an 8-inch diameter disc that was attached to a pole. Agitation liberated submerged oil that rose to the water surface (e.g. sheen or globules). Visual observations were classified using the criteria as illustrated in *Attachment B*.

2.2.1 Station Construction

Initially the TEMS were constructed of Plexiglas® with a wooden support structure. However, due to wave action and decreases in water temperature, the stations became brittle and began to fail. The stations were subsequently re-constructed of reinforced fiber board with angle iron support. The stations were removed at the completion of the TEMS Study.

2.2.2 Data Collection and Analysis

Water temperature (surface and bottom), pre-poling sheen, and water depth were recorded prior to each submerged oil observation. Agitation followed, using one-hand push and two-hand push techniques of poling. Visual observations of the resulting sheen and globules (areal percentage and number, respectively) were recorded. Surface water temperatures were measured at approximately 6 inches from the water surface. Bottom water temperatures were measured at the top of soft sediment. A total of 14 rounds of data were collected from each of the 9 locations between October 14, 2011 through and including October 29, 2011. The TEMS were typically monitored daily or twice per day during the monitoring period depending on weather conditions and river access. During each round of data collection, the parameters listed above were measured and recorded.

The observed sheen percentage per square yard and number of oil globules per square yard as a function of sediment bed surface temperature interval were evaluated. Data was segregated into four bed temperature intervals including 43.7 °F to 45.0 °F, 45.1 °F to 50.0 °F, 50.1 °F to 55.0 °F, and 55.1 °F to 60.2 °F and displayed using box plots. The non-parametric Mann-Whitney statistical test was used to compare median values of sheen percentage between each pair of bed-temperature intervals. The same statistical comparison was conducted for number of globules. The tests were used to determine if the difference between data groups could be attributed to random variation alone or if the groups can be considered significantly different at a 95% confidence level. Graphical presentations of the sheen and globules recorded verses bed surface temperatures are presented as *Figures 2 and 3.*

2.3 Bench Study Methods/Procedures

Sediment and water samples were collected from the Kalamazoo River from a small channel near the left descending bank (LDB) at mile post (MP) 10.75 (*Figure 4*) on December 19, 2011

and transported to the field laboratory (the confluence garage) where the tests were conducted.

River sediment was obtained from a depositional area (channel at 10.75 LDB) that, based on field screening (poling) visual results, previously had been classified in the "heavy" submerged oil category. The selection of this location was done in collaboration with the Submerged Oil Science Group. The poling results in this area have indicated the presence of “heavy” sheening from submerged oil, which has been presumed to indicate substantial concentration of oil in sediment. One sampling crew, with the U.S. EPA oversight, collected the samples on December 19, 2011.

2.3.1 Sediment Collection

A petite Ponar® sampler was used to collect and transfer grab samples of sediment (approximately 6 liters each) into five clean 5-gallon plastic containers. The petite Ponar® was deployed to sample shallow sediments, approximately 5 inches in depth, where oil was believed to be present. During sediment collection, sheen was observed rising to the surface of the river and on the surface of the Ponar® sampler as it was removed from the water. The sediment and water temperatures of the river at the locations of each grab sample as well as general observations were recorded and are presented in *Table 1*. The temperature ranged from 42.7 ^{o}F to 43.9 ^{o}F in sediment and 40.1 ^{o}F to 40.8 ^{o}F in the river water directly above the sediment. The Ponar® sampler was allowed to decant most of the water that came up with the sampler before placing the sediment into the container. Sediment samples in all five containers were observed and photographed under visible and ultraviolet (UV) light, and the appearance of the sediment, texture, color, debris, and other notable features were described. The general presence of sheen/oil on the sediment was noted under visible light and confirmed using a portable UV light viewed under a light blocking portable shanty. The presence, size, and general percent abundance of globules under both visible and UV light was recorded. These field observations were not completed to quantitatively assess the exact percent of sheen and/or globules. Rather they were completed to qualitatively confirm that the sediment selected for this study was sufficiently impacted to meet the study’s objectives. The location of the sediment collection was captured on a YUMA and uploaded for use in the Geographic Information System (GIS). The area location is depicted on *Figure 4*.

Two of the five sample containers were covered with river water in the field by gently pouring river water into the two containers from another 5-gallon plastic container. These samples

were agitated in the field to confirm that the sediment released sheen upon agitation to ensure that the sample contained sheen-generating oil. The three sample containers that were not agitated in the field were covered with a lid for transport to the field laboratory for the study and the two agitated samples were disposed following proper waste disposal procedures. Sample disturbance and movement were minimized and every sample was handled in the same way. In addition to the sediment grab samples, approximately 15 gallons of river water was collected for the study.

2.3.2 Sample Preparation

The sample design included five individual tests consisting of three replicate samples per test. The five tests were completed at five specific target temperatures. The sample preparation and subsequent temperature tests were completed in a secured field laboratory environment. The ambient air temperature within the field laboratory was approximately 65 °F, controlled by a thermostat. Each of the 15 replicate samples consisted of equal volume aliquots from each of the 3 undisturbed grab sample containers, for a total replicate sample volume of 400 milliliters (mL). The aliquots were placed into a 2-liter Nalgene® beaker (7.5-inches tall and 6.25-inches in diameter). The 400 mL of sediment in the replicate sample beakers were then covered by river water, filling the beaker to 1.5 liters. All replicate samples were placed into storage at temperatures maintained between 33 °F and 38 °F.

While preparing the 15 replicate samples, an equal amount of sediment from each of the three containers brought in from the field was placed into a stainless steel bowl. This preparation was completed using the same procedure used to create the 15 replicate samples. Once the 400 mL of sediment was placed into the stainless steel bowl, the sediment was homogenized and a split sample was collected and prepared for laboratory analysis of a single composite sample. The split sample was submitted to the ALS Group USA, Corporation (ALS) and analyzed for Total Petroleum Hydrocarbons (TPH) (measured as Diesel Range Organics (DRO), Oil Range Organics (ORO)), Total Organic Carbon (TOC), and grain size analysis. Samples were analyzed for TPH (DRO and ORO) using Method SW8015M with a reported detection level of 23 milligrams per kilograms (mg/kg) (dry weight) for DRO and 46 mg/kg (dry weight) for ORO. Samples were analyzed for TOC using the Walkley-Black titrametric method with a reported detection level of percent by dry weight. Grain size analysis was performed by Driesenga & Associates, Inc. using ASTM Method D422 with Hydrometer.

2.3.3 Sample Temperature Preparation

The samples, in storage at temperatures between 33 °F and 38 °F, were removed in sets of three at the time of each individual test. Three beakers were placed into a temperature controlled bench top circulating water bath that was set at the desired target temperature. Target water bath temperatures for this test were 35 °F, 45 °F, 55 °F, 65 °F, and 75 °F. Water and sediment sample temperatures were monitored using Omega HH12B digital thermometers until both water and sediment temperatures were stable and within +/- 4 °F of the target temperature.

Once the sediment and water temperatures were stabilized within the target temperature range and recorded, the initial appearance (pre-agitation) and percent coverage of sheen and globules on the water surface were recorded on a clear transparency sheet with grid lines that was placed on top of the beaker. The general appearance of sheen (gray, silver, metallic/transitional), percent coverage, and the presence, size, and abundance of globules on the water surface were noted. Samples were examined under visible and UV light and documented via photographs. The observations began within one minute of the start of the initial agitation.

2.3.4 Sediment Agitation and Data Collection

Prior to agitation, sheen and globules on the surface of the water in the sample container were removed with an absorbent wipe. As the sheen was removed, care was taken to reduce motion so that the sediment in the container was not agitated and the sheen was not further smeared onto the edges of the sample container.

Using a Nalgene® rod (selected to be somewhat representative of poling), the sediment was stirred, initially with one complete circle, and a description of the appearance of sheen and globules on the water surface was recorded on a clear transparency grid that was placed on top of the beaker. The general appearance of sheen (gray, silver, metallic/transitional), percent coverage, and the presence, size, and abundance of globules on the water surface were noted. Samples were examined under visible and UV light and documented via photographs.

Following the initial stir and observations, the sheen and globules were removed from the surface of the water. The sediment was then stirred three more times. The second agitation was intended to occur within approximately 15 minutes of the initial agitation to maintain a

temperature of the water and sediment close to the target temperatures. The three stirs were initiated from the middle of the sample and worked outwards with each turn. A description of the appearance of sheen and globules on the water surface was recorded on a clear transparency grid that was placed on top of the beaker. The general appearance of sheen (gray, silver, metallic/transitional), percent coverage, and the presence, size, and abundance of globules on the water surface were noted. Samples were examined under visible and UV light and documented via photographs. The process was completed for each of the five individual target temperature tests, consisting of three replicate samples per test. For consistency, the same person conducted the agitation of each replicate sample at nearly the same temperatures within the targeted temperature range, while making every effort to follow the exact same procedures. Similarly, a single observer completed the description of the appearance of sheen and globules on the water surface and recorded these observations on a clear transparency grid.

Water and sediment temperatures were re-measured immediately following the recording of all observations and photographs to verify that conditions remained within the target temperature range. After each of the temperature tests, all beakers were placed back into cold storage until the final warm agitation step of the procedure.

2.3.5 Final Warm Agitation

Following the testing of the samples at the 5 temperature ranges, the 15 replicate samples were allowed to cool to 35 °F in cold storage prior to warming the samples to 75 °F. Any sheen present was removed from the surface of the water prior to heating so that only oil liberated during the final heating was documented. The sediment was then agitated again with three stirs as described above. Agitation at a warm temperature following the bench test was intended to confirm that the test results are due to the effect of temperature and agitation, and was not caused by a lack of oil in any sediment aliquot. After the final warm agitation, the water was decanted and the presence or absence of sheen/oil on the remaining sediment surface was observed using visual and UV light and documented with photographs. The observations of sheen and globule cover were made as general estimations and were not recorded on the clear transparency grids.

3.0 Data Evaluation

The following subsections present the results and an evaluation of the TEMS study and the Bench Study.

3.1 TEMS Results and Evaluation

Temperature and poling data for each monitoring event are presented in *Table 2*. The observed sheen percentage per square yard and number of oil globules per square yard as a function of sediment bed surface temperature interval are presented in *Figure 2* and *Figure 3*, respectively. The median values for both percent sheen and also number of globules decrease below a bed temperature of about 55 °F. The observed maximum sheen percentage and maximum number of globules decrease substantially below a bed temperature of about 45 °F.

The sheen percentage data for the highest temperature interval of 55.1 °F to 60.2 °F was noticeably different at the 95% confidence level based on paired comparisons to the data from the other three lower temperature intervals. There was minimal difference at the 95% confidence level between paired sheen percentage data from the three lower temperature intervals. The test results for globule number data segregated by bed temperature interval were the same as those reported for the sheen percentage. The small sample size, study limitations, and other variables need to be considered when making conclusions regarding the results of the study.

There was limited percentage sheen and number of globule data for the low temperature interval of 43.7 °F to 45.0 °F (N=6) and also the high temperature interval of 55.1 °F to 60.2 °F (N=11). The limited data and other variables associated with each TEMS (e.g. initial submerged oil condition, variable depth of agitation, differences in poling techniques, etc.) limit the capacity to develop well supported conclusions. However, the available data from the study suggests that above approximately 55 °F, the bed temperature affects the submerged oil liberation. The relationship between water temperature and submerged oil liberation below 55 °F may remain somewhat stable (limited response) until about 45 °F. Below 45 °F the maximum sheen percentage and number of globules decreased substantially.

3.2 Bench Study Results and Evaluation

A description of the appearance of sheen and globules under visible and UV light were made from each of the five containers. This observation was made in the field within a light blocking shanty. Significant amounts of sheen and globules were observed on the sediment and water surface within each of the containers in both visible and UV light. The percentage of sheen coverage on the sediment and water within the containers ranged from 5% to 60%, and globules ranged from 1/8 to 5/8 inches in diameter. A copy of the field notes are contained in *Attachment C.*

In accordance with the work plan, approximately 1 gallon of river water was added to two of the grab sample containers (containers #4 and #5) and the sediment within the two containers was agitated with a poling rod. Sheen with globules were observed within these containers confirming that sufficient oil was present within the sediment to continue with the study. The two containers were disposed of following proper waste disposal procedures.

The remaining 3 containers were logged for soil type prior to splitting into the 15 replicates for the study. Two of the sample containers (containers #1 and #3) were logged as black sandy silt, with little woody debris and fine gravel, wet. One sample (container #2) was logged as black silty fine sand, little woody debris and fine gravel.

A grain size analysis was completed on the composite sample created in conjunction with the 15 replicates. The soil description, based upon the grain size analysis, was dark brown, fine sandy muck, some organics (root fibers and seashells), and trace gravel. The results of the grain size analysis are presented in *Attachment D*. *Table 1* also presents the results of the analytical composite sample collected and analyzed for TPH (measured as DRO and ORO) and TOC.

3.2.1 Temperature Test Results

The temperature tests began on January 9, 2012. The custody seals on the cold storage unit were broken with Enbridge and U.S. EPA personnel present. The temperature within the cold storage was 34.2 °F. The 35 °F test was started at 0940 with initial temperature readings in the first beaker of 38.3 °F in sediment and 38.1 °F in water. This temperature was within the +/- 4 °F of the 35 °F target temperature; however, by the end of the test the temperatures were outside the target range with sediment temperatures at 42.1 °F and water temperatures at 42.2 °F. A similar variation outside the target temperature range for the final (post test)

temperature check occurred in all three of the 35 °F test aliquots; however, none of the other temperature tests had variations of temperatures outside the target range of (+/- 4 °F). All of the recorded temperatures for pre and post tests are presented in *Table 3*.

The observations made and recorded on the clear transparency grids for each of the 15 sample aliquots are presented in *Attachment E*. Three observations (prior to agitation, after one stir, and after three stirs) were recorded for each aliquot. The areas of sheen and globules observed were calculated by digitizing each outline and calculating the percent of total area. It was determined during the process of the test that presenting globules as a percentage of total area better quantifies the amount of oil globules liberated. For example, reporting in graphical format five small globules being greater than two numerically may not accurately portray that the size of the two may be larger than all five small globules combined. The percent coverage of globules (accurately captured using the transparency sheets, digitized, and calculated within the GIS system) creates a more accurate amount of oil globule to present. The calculated results of the sheen and globule observations are presented in *Tables 4* and *5* respectively.

To analyze the percent sheen and globule results, graphical and statistical representations were considered. It was determined that a statistical evaluation would not be appropriate based upon the data sets of three replicates per target temperature. Essentially, this equates to multiple individual tests with a population size too small for a reliable statistical evaluation. Graphs have been presented to show the study results and are presented in *Figures 5, 6, and 7*.

3.2.2 Temperature Test Evaluation

Graphical depictions of the data are presented in *Figures 5, 6,* and *7*. The two graphs in *Figure 5* show the percentage of observed sheen and percentage of observed globules from each replicate sample and temperature, and depict the percentage prior to agitation, after one stir, and after three stirs. It was noted during the test that some sheen was observed on the water surface of most of the replicate samples prior to placing the sample into the water bath. This sheen was present since the 15 replicate samples were created on December 19, 2011. A step to remove the sheen prior to placing the samples in the water bath was not included in the work plan so removal was not done. After the initial temperature tests were completed, this observation was made and discussed. It was decided that a change in the methodology at this point should not be done and that completing the test with a consistent procedure was

more important. The graphs in *Figure 6* were created to eliminate the minimize inaccuracy of allowing the "old" or "existing" sheen to inappropriately affect the influence that the temperature increase may have on the sheen and globule prior to agitation observations.

Figure 7 depicts line graphs of the total observed sheen and globules following both agitations (top graph), and the observed sheen and globules following the final 75 °F warm up (lower graph). The average sheen and globule coverage increased from 2.5% at 45 °F, to 6% at 55 °F, and to 11% at 65 °F. These trends represent an increase of approximately twice the prior for each 10 °F elevation in temperature. The largest increase observed, however, is from 65 °F to 75 °F. The observed percent coverage increases from 11% to 36%, representing an approximate increase over three times the amount observed at 65 °F.

The lower graph on *Figure 7* depicts the observed sheen and globules at the final warm up stage. The decreasing trend from 35 °F to 75 °F shows that through this test process the sheen and globules liberated from the sediment matrix and removed from the water surface with an absorbent wipe at each of the initial tests did affect the amount of oil remaining in the sample aliquot.

Based on the limited data set and the other limitations of this study, it appears the median response of the sheen is not sensitive for temperatures between 35°F and 55°F.

4.0 Conclusions

The objectives of the TEMS Study and Bench Study on submerged oil were to enhance the understanding of the effects that water and sediment temperatures have on submerged oil liberation. The conclusions that can be drawn from an evaluation of the data presented are general in nature.

4.1 Temperature Effect

The general effect of temperature on the liberation of oil sheen and globules is understood but not quantitatively known. Many other parallel factors (variables) are in play within a complex river environment besides temperature and agitation of sediment. The TEMS study and Bench Study shed light on the relative difference between the ability and inability of oil to liberate from sediment at increasing and/or decreasing temperature. While the TEMS study observations were made at temperatures ranging from 43.7 °F to 60.2 °F, the Bench Study was completed with temperatures ranging from 36.7 °F to 76.2 °F. In general, at the temperatures where there is overlap, the results of the Bench Study are similar to the results of the TEMS Study.

Based upon the Bench Study results, temperature has a steadily increasing effect on the liberation of oil from 35 °F to 65 °F. This increase corresponds to an approximate doubling of the percent observed for each 10 °F temperature increase. However, beyond 65 °F the increase is more substantial. On average, the percent sheen and globules observed is three times higher in the 75 °F test than what was observed in the 65 °F test and approximately 14 times higher than that observed in the 45 °F test.

4.2 Application of Results

Submerged oil within river sediment can be agitated, separated from the sediment matrix, and captured at any of the temperatures studied. However, the effectiveness of this process is dependent on the water and sediment temperatures. This study suggests that performing submerged oil agitation, liberation, and recovery activities at water and sediment temperatures of 55 ^{o}F and 65 ^{o}F can be two to four times more effective than at temperatures below 55 ^{o}F; however, above 65 ^{o}F the effectiveness may increase exponentially.

Application of the observations from this limited study to submerged oil assessment and recovery in the Kalamazoo River may proceed with the understanding that many factors other

than temperature likely contribute to the liberation of sheen from sediment. Understanding the presence of additional influences, assessment and submerged oil liberation and recovery activities involving agitation will likely prove to be minimally effective at temperatures below 55 ^{o}F.

5.0 References

Enbridge, 2011a. Enbridge Line 6B MP 609 Pipeline Release, Marshall, Michigan, *Sampling and Analysis Plan*. Approved August 29, 2011.

Enbridge, 2011b. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; *Addendum to the Response Plan for Downstream Impacted Areas, August 2, 2010 (Revised August 17, 2010 per U.S. EPA August 17, 2010 letter), Supplement to Source Area Response Plan, and Supplement to Response Plan for Downstream Impacted Areas, Referred to as Operations and Maintenance Work Plan Commonly referred to as "Consolidated Work Plan from Fall 2011 through Fall 2012".* Approved December 21, 2011.

Enbridge, 2011c. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; *Supplement to the Response Plan for Downstream Impacted Areas and the Source Area Response Plan Commonly Referred to as the "Overbank and Poling Reassessment Work Plan"*. Approved April 15, 2012

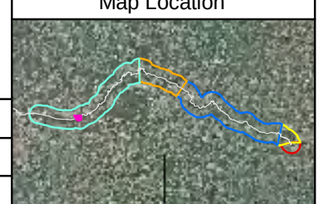
Enbridge, 2012. Line 6B MP 608 Pipeline Release; Marshall, Michigan; *Health and Safety Plan.* April 19, 2012.

Figures

ENBRIDGE

Drawn:	BRS 11/29/2011
Approved:	DBR 11/29/2011
Project #:	106-4186

Map Location



Legend

- TEMS Monitoring Locations
- Quarter Mile Grid Segment

N

0 50 100 200

Scale in Feet

FIGURE 1
TEMS MONITORING LOCATIONS

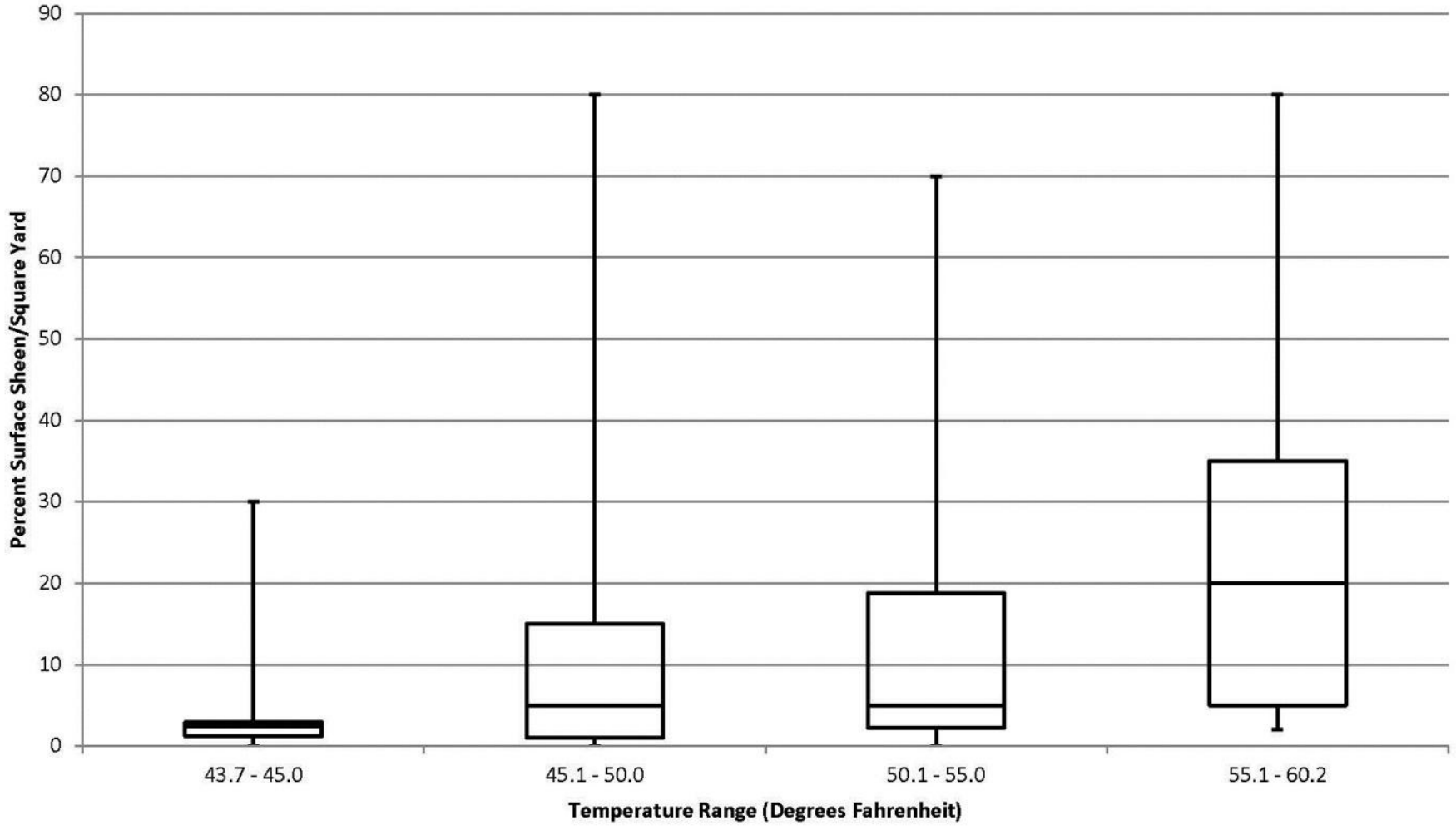
MP 36.50

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

X:\ArcMap Project Files\Tech Memos\TEMS Monitoring Locations Figure 1.mxd

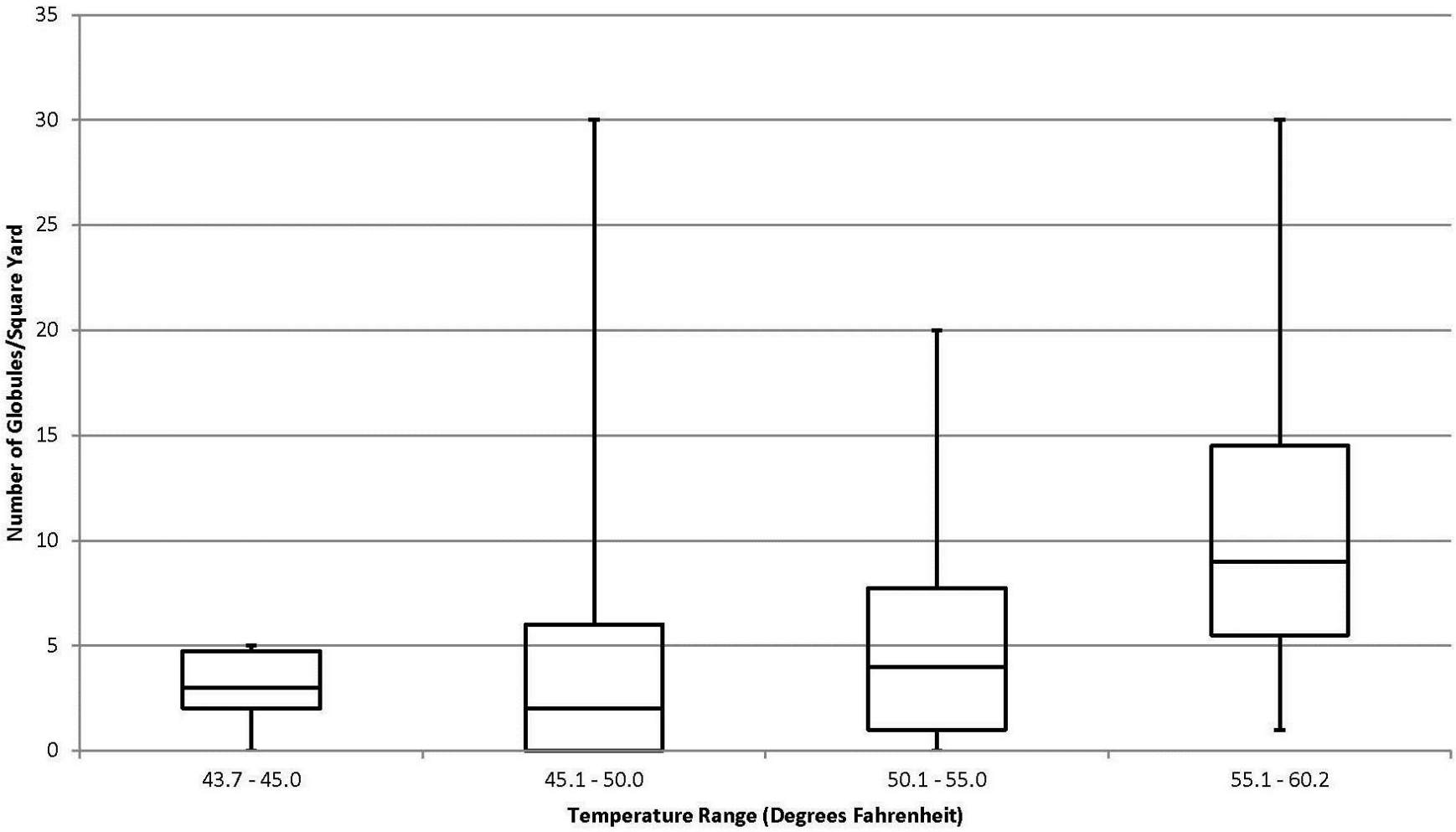
Aerial Photography Date: April 2011

Figure 2: Observed Sheen Percentage vs. Bed Surface Temperature
Enbridge Line 6B MP 608 Marshall, MI Pipeline Release
Enbridge Energy, Limited Partnership



N	6	69	38	11
Min	0	0	0	2
Q1	1.25	1	2.25	5
Median	2.5	5	5	20
Q3	3	15	18.75	35
Max	30	80	70	80

Figure 3: Observed Globules vs. Bed Surface Temperature
Enbridge Line 6B MP 608 Marshall, MI Pipeline Release
Enbridge Energy, Limited Partnership

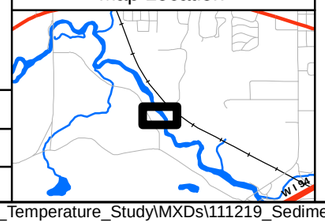


N	6	69	38	11
Min	0	0	0	1
Q1	2	0	1	5.5
Median	3	2	4	9
Q3	4.75	6	7.75	14.5
Max	5	30	20	30

ENBRIDGE

Drawn:	NS	4/4/2012
Approved:	MS	4/4/2012
Project #:	60162778	

Map Location



Legend

- Sediment Sample
- Quarter Mile Grid Segments

Submerged Oil

- Moderate
- Heavy

Submerged Oil Category

- Heavy
- Moderate
- Light
- None

N

0 40 80 160

Scale in Feet

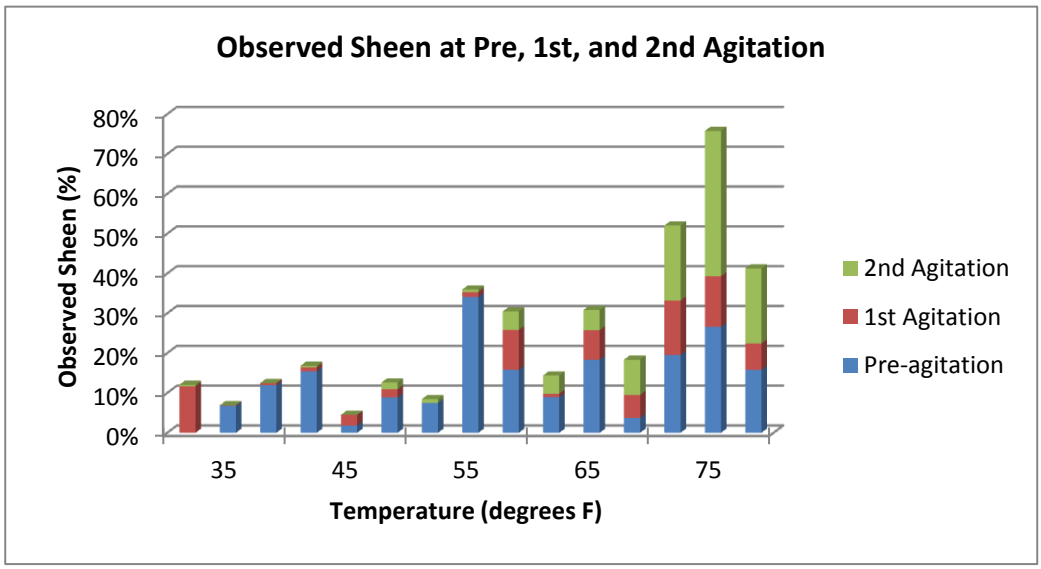
FIGURE 4
SEDIMENT TEMPERATURE STUDY
MP 10.75

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Z:\Work\GIS\Submerged_Oil\Sediment_Temperature_Study\MXDs\111219_Sediment_Temp_Study_MP_10_75.mxd

Aerial Photography Date: April 2011

Figure 5: Percent Sheen and Globules at Pre, 1st, and 2nd Agitation
Enbridge Line 6B MP 608 Marshall, MI Pipeline Release
Enbridge Energy, Limited Partnership



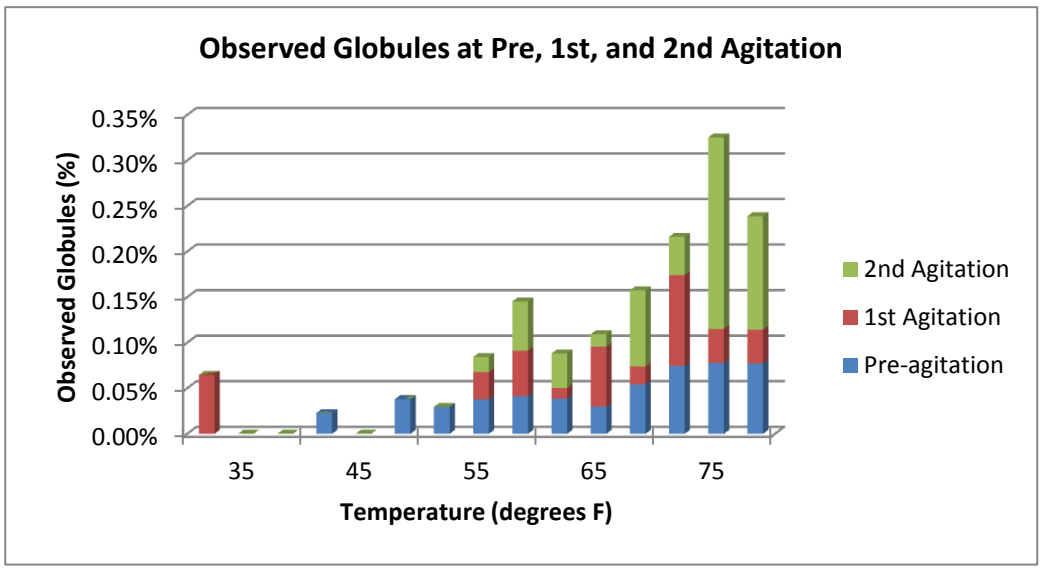
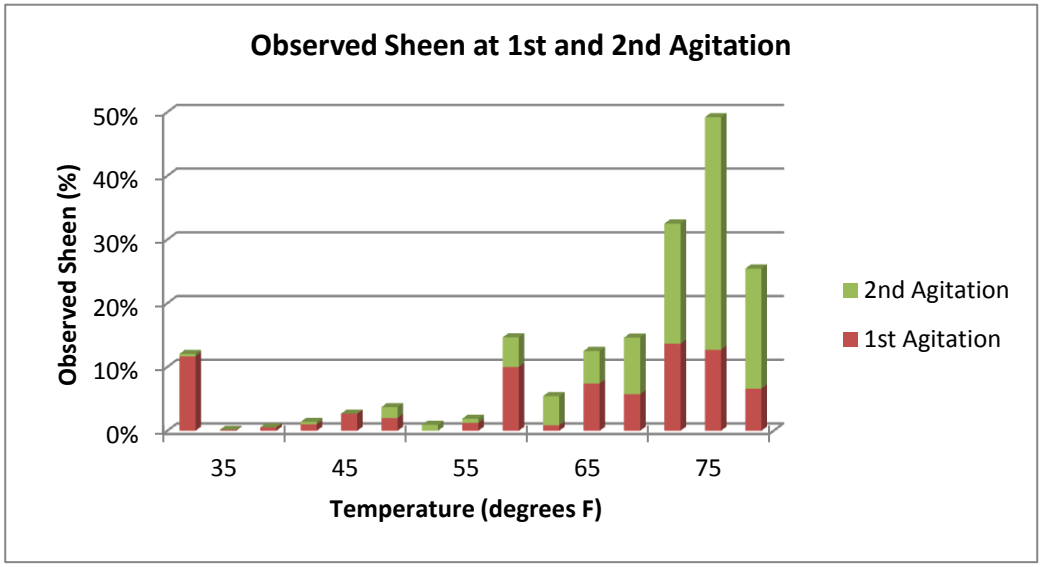
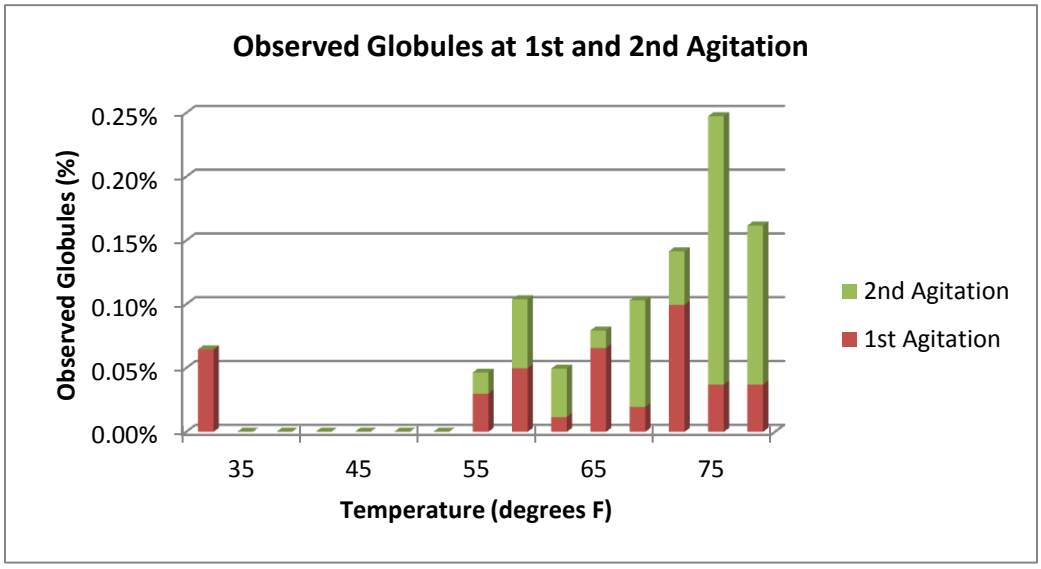
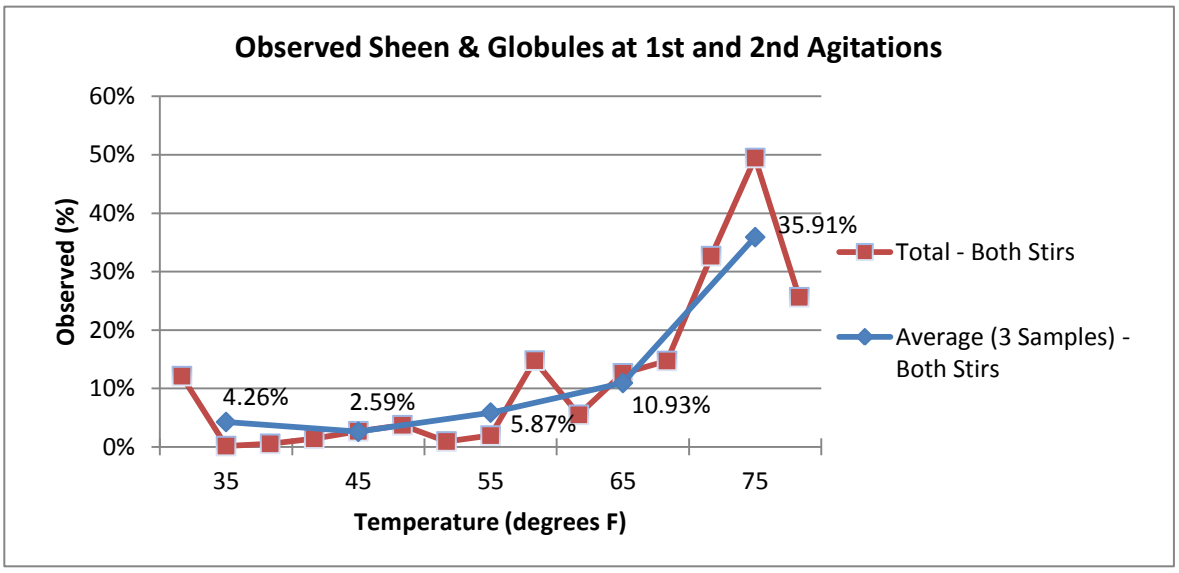
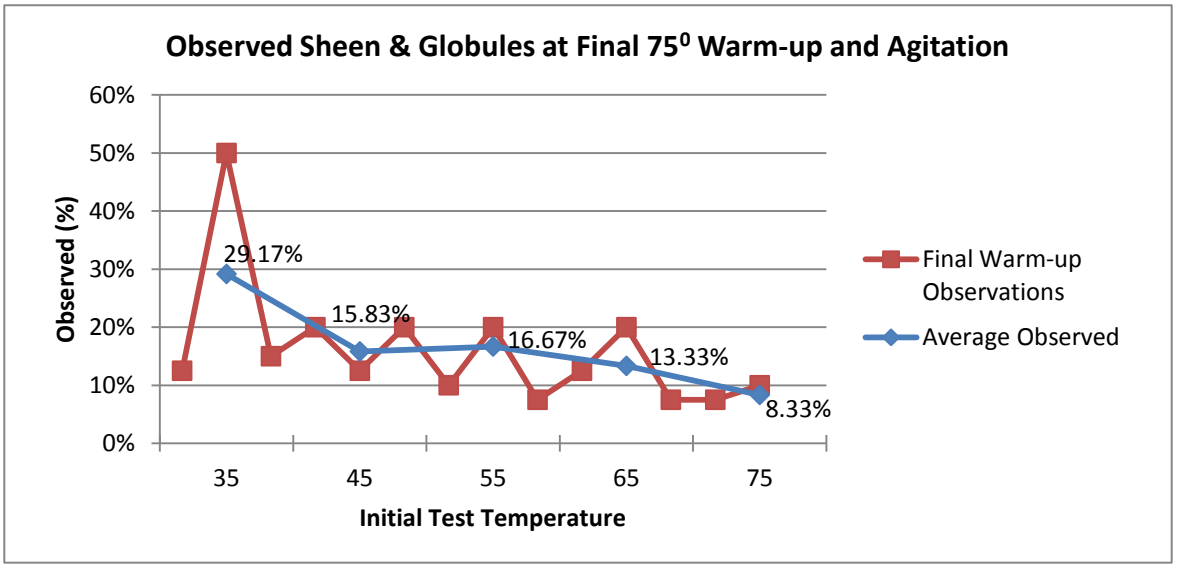


Figure 6: Percent Sheen and Globules at 1st and 2nd Agitation
Enbridge Line 6B MP 608 Marshall, MI Pipeline Release
Enbridge Energy, Limited Partnership









Tables

Table 1. Sediment and Water Temperatures/Sediment Analytical Results
Enbridge Line 6B MP 608 Marshall, MI Pipeline Release
Enbridge Energy, Limited Partnership

Temperature (Sediment)	Temperature (Water)	Date	Time	Bucket Number	% Sheen (UV)	Visible Sheen
43.1	40.5	12/19/2011	1020	1	50-60%	Heavy Sheen
42.7	40.1	12/19/2011	1100	2	5%	Light Sheen
43.9	40.5	12/19/2011	1100	3	30-40%	Heavy Sheen
43.1	40.5	12/19/2011	1123	4	5%	Light-Moderate Sheen
43.3	40.8	12/19/2011	1131	5	50%	Heavy Sheen

	Date Collected	12/19/2011 3:00 PM
	Sample	SEKR1075L 201S 121911DX
	Matrix	SE
Analyte	Units	Result
Carbon		
Total Organic Carbon	%	**3.8**
Solids		
Moisture	%	**59**
TPH		
Diesel Range Organics (C10-C20)	mg/kg	**170**
Oil Range Organics (C20-C34)	mg/kg	**880**

Table 1. Footnotes - Sediment and Water Temperatures/Sediment Analytical Results
Enbridge Line 6B MP 608 Marshall, MI Pipeline Release
Enbridge Energy, Limited Partnership

Sediment Footnotes:
Bold values are concentrations detected above the reporting limit.
% = percent.
mg/kg = milligrams per kilogram.
TPH = total petroleum hydrocarbon.

Location Information				Install										
						Temperature Readings (°F)			Poling Information					
Temperature ID	Easting	Northing	Elevation	Date	Time	Surface	Bottom	Pre-Poling Sheen	Water Depth (ft)	One-hand Push (ft)	Two-hand Push (ft)	Submerged Oil Category	Sheen	Globules
TEMS-01	12836619	285834	776.06	10/14/11	15:00	58.4	59.1	5%	0.9	1.5	2.6	Light	Light (15%)	Few (8)
TEMS-02	12836603	285944	775.00	10/14/11	15:41	58.8	60.0	20%	0.7	1.4	2.3	Moderate	Moderate (25%)	Common (12)
TEMS-03	12836705	285951	774.06	10/14/11	16:04	58.2	58.5	50%	2.5	0.1	0.5	Heavy	Heavy (80%)	Many (26)
TEMS-04	12836635	285971	775.42	10/14/11	16:28	58.9	59.0	15%	1.4	0.1	0.3	Light	Light (25%)	Few (9)
TEMS-05	12836457	286048	775.53	10/14/11	16:54	59.5	60.2	5%	2.6	0.9	1.3	Moderate	Moderate (45%)	Common (17)
TEMS-06	12836339	286167	775.60	10/14/11	17:09	57.5	58.5	30%	1.1	1.3	3.5	Moderate	Moderate (50%)	Many (30)
TEMS-07	12836240	286199	--	10/17/11	14:04	54.1	53.9	0%	0.7	1.4	1.7	Heavy	Heavy (70%)	Common (20)
TEMS-08	12836358	286121	775.64	10/17/11	15:18	55.9	55.9	10%	1.3	1.1	1.9	Light	Light (20%)	Few (6)
TEMS-09	12836404	286091	775.47	10/17/11	15:56	56.4	56.4	5%	2.0	0.8	1.8	Light	Light (5%)	Few (2)
Location Information				**Round 1**										
						Temperature Readings (°F)			Poling Information					
Temperature ID	Easting	Northing	Elevation	Date	Time	Surface	Bottom	Pre-Poling Sheen	Water Depth (ft)	One-hand Push (ft)	Two-hand Push (ft)	Submerged Oil Category	Sheen	Globules
TEMS-01	12836619	285834	776.06	10/18/2011	11:01:09	45.5	45.4	5% (0 globules)	1.5	1.0	2.5	Light	Light (5%)	None (0)
TEMS-02	12836603	285944	775.00	10/18/2011	11:20:14	49.0	51.3	5% oil, 80% biological (1 globule)	0.6	1.1	2.7	Light	Light (5%)	Few (1)
TEMS-03	12836705	285951	774.06	10/18/2011	11:50:29	51.0	52.4	0% oil, 90% biological (0 globules)	2.2	0.5	1.2	Light	Light (10%)	Few (3)
TEMS-04	12836635	285971	775.42	10/18/2011	12:03:24	49.5	49.8	0% (0 globules)	1.5	0.9	1.9	Light	Light (1%)	None (0)
TEMS-05	12836457	286048	775.53	Unable to pole due to time/weather										
TEMS-06	12836339	286167	775.60	Unable to pole due to time/weather										
TEMS-07	12836240	286199	--	Unable to pole due to time/weather										
TEMS-08	12836358	286121	775.64	Unable to pole due to time/weather										
TEMS-09	12836404	286091	775.47	Unable to pole due to time/weather										
Location Information				**Round 2**										
						Temperature Readings (°F)			Poling Information					
Temperature ID	Easting	Northing	Elevation	Date	Time	Surface	Bottom	Pre-Poling Sheen	Water Depth (ft)	One-hand Push (ft)	Two-hand Push (ft)	Submerged Oil Category	Sheen	Globules
TEMS-01	12836619	285834	776.06	10/19/2011	11:07:58	48.4	50.3	0% (0 globules)	1.6	1.0	2.4	Light	Light (5%)	Few (2)
TEMS-02	12836603	285944	775.00	10/19/2011	11:02:28	49.0	49.4	0% (0 globules)	1.0	1.0	1.6	Light	Light (5%)	Few (2)
TEMS-03	12836705	285951	774.06	10/19/2011	10:53:26	49.6	52.1	20% (0 globules)	2.0	0.8	1.9	Light	Light (5%)	Few (3)
TEMS-04	12836635	285971	775.42	10/19/2011	10:43:58	49.7	50.4	5% (0 globules)	1.9	0.6	1.1	Light	Light (5%)	None (0)
TEMS-05	12836457	286048	775.53	10/19/2011	10:05:23	50.7	50.9	0% (0 globules)	2.4	0.8	1.8	Light	Light (1%)	None (0)
TEMS-06	12836339	286167	775.60	10/19/2011	10:34:42	50.2	50.9	0% (0 globules)	1.2	2.0	4.1	Light	Light (15%)	Few (5)
TEMS-07	12836240	286199	--	Monitoring Station #7 Damaged										
TEMS-08	12836358	286121	775.64	10/19/2011	10:26:17	51.6	51.8	0% (0 globules)	1.0	1.0	2.0	Light	Light (5%)	None (0)
TEMS-09	12836404	286091	775.47	10/19/2011	10:13:46	51	54.1	0% (0 globules)	2.0	0.5	1.5	Light	Light (<1%)	None (0)
Location Information				**Round 3**										
						Temperature Readings (°F)			Poling Information					
Temperature ID	Easting	Northing	Elevation	Date	Time	Surface	Bottom	Pre-Poling Sheen	Water Depth (ft)	One-hand Push (ft)	Two-hand Push (ft)	Submerged Oil Category	Sheen	Globules
TEMS-01	12836619	285834	776.06	10/20/2011	11:16:31	46.8	46.4	0% (0 globules)	1.7	1.3	2.3	None	None (0%)	None (0)
TEMS-02	12836603	285944	775.00	10/20/2011	11:30:43	48.2	48.2	0% (0 globules)	1.2	0.7	1.4	Light	Light (1%)	None (0)
TEMS-03	12836705	285951	774.06	10/20/2011	11:54:26	48.7	46.5	0% (0 globules)	2.8	0.6	1.6	Light	Light (5%)	Few (2)
TEMS-04	12836635	285971	775.42	Monitoring Station #4 Damaged										
TEMS-05	12836457	286048	775.53	10/20/2011	12:09:27	48.3	48.0	0% (0 globules)	2.8	0.7	1.9	Light	Light (5%)	Few (1)
TEMS-06	12836339	286167	775.60	10/20/2011	12:29:32	50.0	49.0	0% (0 globules)	2.0	1.0	3.0	Light	Light (20%)	Few (5)
TEMS-07	12836240	286199	--	Monitoring Station #7 Damaged										
TEMS-08	12836358	286121	775.64	10/20/2011	12:21:08	48.3	47.8	0% (0 globules)	1.3	0.7	2.5	Light	Light (1%)	None (0)
TEMS-09	12836404	286091	775.47	10/20/2011	12:15:50	48.9	48.6	0% (0 globules)	2.2	0.4	1.0	Light	Light (1%)	None (0)
Location Information				**Round 4**										
						Temperature Readings (°F)			Poling Information					
Temperature ID	Easting	Northing	Elevation	Date	Time	Surface	Bottom	Pre-Poling Sheen	Water Depth (ft)	One-hand Push (ft)	Two-hand Push (ft)	Submerged Oil Category	Sheen	Globules
TEMS-01	12836619	285834	776.06	10/21/2011	11:23:45	49.2	49.9	0% (0 globules)	1.6	0.5	2.4	Light	Light (1%)	Few (1)
TEMS-02	12836603	285944	775.00	10/21/2011	11:35:51	49.5	50.0	0% (0 globules)	1.3	1.3	1.6	Light	Light (1%)	None (0)
TEMS-03	12836705	285951	774.06	10/21/2011	11:46:48	48.6	49.2	0% (0 globules)	2.4	0.6	0.8	Light	Light (1%)	None (0)
TEMS-04	12836635	285971	775.42	Monitoring Station #4 Damaged										
TEMS-05	12836457	286048	775.53	Monitoring Station #5 Damaged										
TEMS-06	12836339	286167	775.60	10/21/2011	12:48:31	49.2	49.6	20% (4 globules)	1.4	2.1	4.6	Light	Light (20%)	Few (1)
TEMS-07	12836240	286199	--	10/21/2011	13:23:53	49.8	49.8	N/A: Reinstalled	0.7	1.6	2.1	Light	Light (20%)	Few (8)
TEMS-08	12836358	286121	775.64	10/21/2011	12:33:17	49.2	49.8	0% (0 globules)	1.4	0.9	2.6	Light	Light (1%)	None (0)
TEMS-09	12836404	286091	775.47	10/21/2011	12:23:53	49.6	49.4	0% (0 globules)	2.3	0.6	0.9	Light	Light (1%)	None (0)

Location Information				Round 5											
						Temperature Readings (°F)			Poling Information						
Temperature ID	Easting	Northing	Elevation	Date	Time	Surface	Bottom	Pre-Poling Sheen	Water Depth (ft)	One-hand Push (ft)	Two-hand Push (ft)	Submerged Oil Category	Sheen	Globules
TEMS-01	12836619	285834	776.06	10/22/2011	14:10:01	52.8	52.8	0% (0 globules)	1.4	1.3	1.9	Light	Light (20%)	Few (5)
TEMS-02	12836603	285944	775.00	10/22/2011	14:28:13	50.9	50.7	0% (0 globules)	1.4	1.0	1.2	Light	Light (5%)	Few (1)
TEMS-03	12836705	285951	774.06	10/22/2011	14:44:12	51.3	48.2	0% (0 globules)	2.3	0.5	0.7	Light	Light (2%)	Few (1)
TEMS-04	12836635	285971	775.42	10/22/2011	14:48:02	50.0	49.5	0% (0 globules)	1.7	1.0	1.3	Light	Light (8%)	Few (4)
TEMS-05	12836457	286048	775.53	Monitoring Station #5 Damaged										
TEMS-06	12836339	286167	775.60	10/22/2011	13:53:14	47.0	46.4	40% (0 globules)	1.1	1.3	2.7	Moderate	Heavy (80%)	Few (2)
TEMS-07	12836240	286199	--	10/22/2011	13:42:01	47.7	47.6	20% (4 globules)	0.7	1.2	1.7	Light	Light (20%)	Few (9)
TEMS-08	12836358	286121	775.64	10/22/2011	14:01:09	50.2	49.9	0% (0 globules)	1.6	0.7	1.0	None	None (0%)	None (0)
TEMS-09	12836404	286091	775.47	10/22/2011	15:03:00	52.1	47.4	0 % (0 globules)	2.2	0.4	1.0	Light	Light (2%)	Few (2)

Location Information				Round 6											
						Temperature Readings (°F)			Poling Information						
Temperature ID	Easting	Northing	Elevation	Date	Time	Surface	Bottom	Pre-Poling Sheen	Water Depth (ft)	One-hand Push (ft)	Two-hand Push (ft)	Submerged Oil Category	Sheen	Globules
TEMS-01	12836619	285834	776.06	10/24/2011	16:17:10	56.8	56.1	0% (0 globules)	1.9	1.2	1.9	Light	Light (5%)	Few (5)
TEMS-02	12836603	285944	775.00	10/24/2011	16:25:27	53.6	53.0	0% (0 globules)	1.4	1.1	1.6	None	None (0%)	None (0)
TEMS-03	12836705	285951	774.06	10/24/2011	16:42:20	53.5	52.1	0% (0 globules)	2.5	0.9	1.0	Light	Light (10%)	Few (6)
TEMS-04	12836635	285971	775.42	10/24/2011	16:59:08	52.8	53.0	0% (0 globules)	2.2	0.7	0.8	Moderate	Moderate (30%)	Common (12)
TEMS-05	12836457	286048	775.53	10/24/2011	17:07:38	54.6	55.7	0% (0 globules)	3.0	0.1	1.2	Light	Light (2%)	Few (1)
TEMS-06	12836339	286167	775.60	10/24/2011	17:28:59	54.6	54.4	2% (0 globules)	1.5	2.3	3.9	Moderate	Light (10%)	Common (15)
TEMS-07	12836240	286199	--	10/24/2011	15:56:23	52.7	52.3	2% (2 globules)	0.7	0.8	2.0	Moderate	Moderate (30%)	Few (7)
TEMS-08	12836358	286121	775.64	10/24/2011	17:22:11	55.0	54.8	0% (0 globules)	1.6	0.4	1.7	Light	Light (3%)	Few (3)
TEMS-09	12836404	286091	775.47	10/24/2011	17:15:52	55.3	52.2	1 % (0 globules)	2.6	1.0	1.6	Light	Light (2%)	Few (1)

Location Information				Round 7											
						Temperature Readings (°F)			Poling Information						
Temperature ID	Easting	Northing	Elevation	Date	Time	Surface	Bottom	Pre-Poling Sheen	Water Depth (ft)	One-hand Push (ft)	Two-hand Push (ft)	Submerged Oil Category	Sheen	Globules
TEMS-01	12836619	285834	776.06	10/25/2011	10:22:23	49.0	50.0	0% (0 globules)	1.7	1.8	2.3	Light	Light (10%)	Few (8)
TEMS-02	12836603	285944	775.00	10/25/2011	10:33:33	48.8	49.0	1% (0 globules)	1.3	1.2	1.5	Light	Light (1%)	Few (2)
TEMS-03	12836705	285951	774.06	10/25/2011	10:54:01	49.2	49.5	0% (0 globules)	2.5	0.6	0.8	Moderate	Light (10%)	Common (12)
TEMS-04	12836635	285971	775.42	10/25/2011	10:43:53	49.5	49.6	1% (0 globules)	2.0	0.9	1.4	Moderate	Light (12%)	Many (30)
TEMS-05	12836457	286048	775.53	10/25/2011	10:12:39	49.2	50.2	1% (0 globules)	2.9	0.3	1.4	Light	Light (2%)	Few (5)
TEMS-06	12836339	286167	775.60	10/25/2011	9:40:45	48.7	49.6	5% (4 globules)	1.5	2.3	3.8	Moderate	Light (10%)	Common (10)
TEMS-07	12836240	286199	--	10/25/2011	9:24:39	48.1	48.2	10% (12 globules)	1.0	1.4	1.6	Moderate	Moderate (30%)	Common (11)
TEMS-08	12836358	286121	775.64	10/25/2011	9:54:02	48.5	48.7	5% (0 globules)	1.3	0.7	2.0	Light	Light (5%)	Few (3)
TEMS-09	12836404	286091	775.47	10/25/2011	10:03:16	49.0	50.3	1% (0 globules)	2.5	0.7	1.6	Light	Light (1%)	Few (1)

Location Information				Round 8											
						Temperature Readings (°F)			Poling Information						
Temperature ID	Easting	Northing	Elevation	Date	Time	Surface	Bottom	Pre-Poling Sheen	Water Depth (ft)	One-hand Push (ft)	Two-hand Push (ft)	Submerged Oil Category	Sheen	Globules
TEMS-01	12836619	285834	776.06	10/25/2011	14:36:48	56.2	55.3	0% (0 globules)	1.7	1.8	2.2	Moderate	Light (5%)	Common (11)
TEMS-02	12836603	285944	775.00	10/25/2011	14:49:59	52.9	50.6	0% (0 globules)	1.5	1.0	1.2	None	None (0%)	None (0)
TEMS-03	12836705	285951	774.06	10/25/2011	15:07:05	52.8	50.3	1% (0 globules)	2.5	0.6	0.9	Moderate	Light (20%)	Common (14)
TEMS-04	12836635	285971	775.42	10/25/2011	14:58:52	53.4	52.3	0% (0 globules)	2.0	0.6	1.0	Light	Light (15%)	Few (8)
TEMS-05	12836457	286048	775.53	10/25/2011	15:16:17	53.5	53.4	0% (0 globules)	3.0	0.8	1.4	Light	Light (5%)	Few (6)
TEMS-06	12836339	286167	775.60	10/25/2011	15:46:31	52.4	50.3	1% (3 globules)	1.5	3.6	4.1	Moderate	Light (20%)	Common (10)
TEMS-07	12836240	286199	--	10/25/2011	16:00:48	53.4	52.6	50% (18 globules)	1.0	1.4	1.7	Moderate	Moderate (30%)	Few (9)
TEMS-08	12836358	286121	775.64	10/25/2011	15:35:37	54.0	53.9	0% (0 globules)	1.6	0.4	1.0	Light	Light (3%)	Few (3)
TEMS-09	12836404	286091	775.47	10/25/2011	15:24:26	54.2	51.1	0% (0 globules)	2.5	1.0	1.7	Light	Light (1%)	Few (2)

Location Information				Round 9											
						Temperature Readings (°F)			Poling Information						
Temperature ID	Easting	Northing	Elevation	Date	Time	Surface	Bottom	Pre-Poling Sheen	Water Depth (ft)	One-hand Push (ft)	Two-hand Push (ft)	Submerged Oil Category	Sheen	Globules
TEMS-01	12836619	285834	776.06	10/26/2011	16:25:00	51.0	52.2	1% (2 globules)	1.4	2.0	2.5	Light	Light (6%)	Few (5)
TEMS-02	12836603	285944	775.00	10/26/2011	16:35:00	50.8	51.3	0% (0 globules)	1.4	1.1	1.3	Light	Light (1%)	Few (2)
TEMS-03	12836705	285951	774.06	10/26/2011	16:52:00	51.3	53.1	0% (0 globules)	2.0	0.9	1.0	Moderate	Light (15%)	Common (12)
TEMS-04	12836635	285971	775.42	10/26/2011	16:45:00	51.2	51.4	0% (0 globules)	1.7	0.9	1.3	Moderate	Light (25%)	Common (12)
TEMS-05	12836457	286048	775.53	10/26/2011	16:03:00	51.3	52.0	1% (4 globules)	2.6	0.4	1.6	Light	Light (15%)	Few (8)
TEMS-06	12836339	286167	775.60	10/26/2011	15:02:00	50.9	52.6	10% (3 globules)	1.4	1.9	4.0	Light	Light (20%)	Few (6)
TEMS-07	12836240	286199	--	10/26/2011	15:26:00	51.0	51.0	0% (0 globules)	0.6	1.5	1.9	Light	Light (20%)	Few (7)
TEMS-08	12836358	286121	775.64	10/26/2011	14:37:00	51.1	51.3	0% (0 globules)	1.5	1.0	1.5	Light	Light (5%)	None (3)
TEMS-09	12836404	286091	775.47	10/26/2011	16:17:00	51.6	52.8	1% (1 globules)	2.1	0.5	1.8	Light	Light (1%)	Few (1)

Table 2. Temperature Monitoring
Enbridge Line 6B MP 608 Marshall, MI Pipeline Release
Enbridge Energy, Limited Partnership

Location Information				Round 10											
						Temperature Readings (°F)			Poling Information						
Temperature ID	Easting	Northing	Elevation	Date	Time	Surface	Bottom	Pre-Poling Sheen	Water Depth (ft)	One-hand Push (ft)	Two-hand Push (ft)	Submerged Oil Category	Sheen	Globules
TEMS-01	12836619	285834	776.06	10/27/2011	10:16:40	46.7	49.2	1% (2 globules)	1.4	1.6	2.3	Light	Light (10%)	Few (6)
TEMS-02	12836603	285944	775.00	10/27/2011	10:26:14	47.5	49.2	0% (0 globules)	1.2	1.2	1.5	Light	Light (1%)	Few (1)
TEMS-03	12836705	285951	774.06	10/27/2011	10:46:20	48.7	49.8	0% (0 globules)	2.1	0.8	1.0	Moderate	Moderate (30%)	Common (18)
TEMS-04	12836635	285971	775.42	10/27/2011	10:36:20	48.7	49.7	0% (0 globules)	1.7	0.8	1.4	Moderate	Moderate (30%)	Few (7)
TEMS-05	12836457	286048	775.53	10/27/2011	11:00:13	48.4	48.6	0% (0 globules)	2.8	0.2	0.9	None	None (0%)	None (0)
TEMS-06	12836339	286167	775.60	10/27/2011	11:26:21	48.5	49.1	0% (1 globule)	1.1	2.5	3.9	Moderate	Moderate (40%)	Common (13)
TEMS-07	12836240	286199	--	10/27/2011	9:54:08	47.9	48.3	0% (0 globules)	0.5	0.7	0.9	Light	Light (25%)	Few (9)
TEMS-08	12836358	286121	775.64	10/27/2011	11:17:42	48.7	48.8	0% (0 globules)	1.4	1.2	1.7	Light	Light (1%)	Few (2)
TEMS-09	12836404	286091	775.47	10/27/2011	11:09:20	48.8	48.9	1% (0 globules)	1.9	0.6	1.1	Light	Light (1%)	Few (3)
Location Information				Round 11											
						Temperature Readings (°F)			Poling Information						
Temperature ID	Easting	Northing	Elevation	Date	Time	Surface	Bottom	Pre-Poling Sheen	Water Depth (ft)	One-hand Push (ft)	Two-hand Push (ft)	Submerged Oil Category	Sheen	Globules
TEMS-01	12836619	285834	776.06	10/28/2011	11:05:00	41.7	46.6	2% (0 globules)	1.3	2.1	2.5	Moderate	Light (5%)	Common (10)
TEMS-02	12836603	285944	775.00	10/28/2011	11:12:00	43.3	45.7	0% (0 globules)	1.1	1.3	1.6	Light	Light (1%)	None (0)
TEMS-03	12836705	285951	774.06	10/28/2011	11:31:00	45.3	49.4	1% (3 globules)	2.0	0.9	1.3	Light	Light (15%)	Few (8)
TEMS-04	12836635	285971	775.42	10/28/2011	11:25:00	44.4	45.0	1% (4 globules)	1.7	0.9	1.3	Moderate	Moderate (30%)	Few (5)
TEMS-05	12836457	286048	775.53	10/28/2011	11:35:00	45.4	48.2	5% (1 globule)	2.5	1.0	1.5	Light	Light (25%)	Few (7)
TEMS-06	12836339	286167	775.60	10/28/2011	10:50:00	44.8	46.2	20% (15 globules)	1.6	3.0	3.4	Light	Light (20%)	Few (6)
TEMS-07	12836240	286199	--	10/28/2011	9:56:00	42.5	43.7	3% (4 globules)	0.6	1.5	1.6	Light	Light (3%)	Few (4)
TEMS-08	12836358	286121	775.64	10/28/2011	10:40:00	44.3	44.3	0% (0 globules)	1.3	0.2	1.8	Light	Light (1%)	Few (2)
TEMS-09	12836404	286091	775.47	10/28/2011	10:21:00	44.9	45.0	0% (0 globules)	2.0	0.9	1.1	None	None (0%)	None (0)
Location Information				Round 12											
						Temperature Readings (°F)			Poling Information						
Temperature ID	Easting	Northing	Elevation	Date	Time	Surface	Bottom	Pre-Poling Sheen	Water Depth (ft)	One-hand Push (ft)	Two-hand Push (ft)	Submerged Oil Category	Sheen	Globules
TEMS-01	12836619	285834	776.06	10/28/2011	15:38:00	44.8	44.9	0% (0 globules)	1.4	2.0	2.2	Light	Light (2%)	Few (5)
TEMS-02	12836603	285944	775.00	10/28/2011	15:30:00	46.8	46.4	0% (0 globules)	1.2	1.3	1.7	Light	Light (1%)	Few (1)
TEMS-03	12836705	285951	774.06	10/28/2011	15:08:00	47.5	46.8	0% (0 globules)	2.1	0.7	0.8	Moderate	Moderate (45%)	Common (16)
TEMS-04	12836635	285971	775.42	10/28/2011	15:25:00	47.2	46.5	0% (0 globules)	1.7	0.8	1.1	Light	Light (5%)	Few (6)
TEMS-05	12836457	286048	775.53	10/28/2011	15:45:00	46.2	47.3	5% (4 globules)	2.6	0.9	1.3	Light	Light (3%)	Few (6)
TEMS-06	12836339	286167	775.60	10/28/2011	16:10:00	47.4	47.2	40% (16 globules)	1.0	3.5	4.0	Light	Light (15%)	Few (7)
TEMS-07	12836240	286199	--	10/28/2011	14:40:00	46.2	46.1	1% (1 globule)	0.8	1.2	1.5	Light	Light (5%)	Few (8)
TEMS-08	12836358	286121	775.64	10/28/2011	16:00:00	47.3	47.8	0% (0 globules)	1.5	0.5	1.0	Light	Light (1%)	Few (2)
TEMS-09	12836404	286091	775.47	10/28/2011	15:53:00	45.9	45.4	0 % (0 globules)	2.0	0.9	1.7	Light	Light (1%)	None (0)
Location Information				Round 13											
						Temperature Readings (°F)			Poling Information						
Temperature ID	Easting	Northing	Elevation	Date	Time	Surface	Bottom	Pre-Poling Sheen	Water Depth (ft)	One-hand Push (ft)	Two-hand Push (ft)	Submerged Oil Category	Sheen	Globules
TEMS-01	12836619	285834	776.06	10/29/2011	9:48:00	42.3	45.1	10% (0 globules)	1.4	2.0	2.2	Light	Light (25%)	Few (4)
TEMS-02	12836603	285944	775.00	10/29/2011	10:00:00	42.6	45.9	0% (0 globules)	1.2	1.3	1.7	None	None (0%)	None (0)
TEMS-03	12836705	285951	774.06	10/29/2011	10:10:00	44.2	47.4	1% (1 globules)	2.1	0.7	0.8	Light	Light (5%)	Few (2)
TEMS-04	12836635	285971	775.42	10/29/2011	10:05:00	43.9	45.0	1% (1 globules)	1.7	0.8	1.1	Light	Light (3%)	Few (2)
TEMS-05	12836457	286048	775.53	10/29/2011	9:38:00	44.6	48.7	0% (0 globules)	2.6	0.9	1.3	None	Light (2%)	Few (1)
TEMS-06	12836339	286167	775.60	10/29/2011	10:32:00	46.3	46.2	25% (4 globules)	1.0	3.5	4.0	Light	Moderate (35%)	Few (6)
TEMS-07	12836240	286199	--	10/29/2011	9:20:00	44.1	45.3	2% (2 globules)	0.8	1.2	1.5	Light	Light (2%)	Few (2)
TEMS-08	12836358	286121	775.64	10/29/2011	10:25:00	44.8	45.2	0% (0 globules)	1.5	0.5	1.0	None	None (0%)	None (0)
TEMS-09	12836404	286091	775.47	10/29/2011	10:17:00	44.4	45.7	0 % (0 globules)	2.0	0.9	1.7	None	None (0%)	None (0)
Location Information				Round 14											
						Temperature Readings (°F)			Poling Information						
Temperature ID	Easting	Northing	Elevation	Date	Time	Surface	Bottom	Pre-Poling Sheen	Water Depth (ft)	One-hand Push (ft)	Two-hand Push (ft)	Submerged Oil Category	Sheen	Globules
TEMS-01	12836619	285834	776.06	10/29/2011	13:52:00	47.8	49.8	0% (0 globules)	1.4	2.0	2.2	None	Light (1%)	Few (2)
TEMS-02	12836603	285944	775.00	10/29/2011	13:59:00	47.4	45.4	0% (0 globules)	1.2	1.3	1.7	None	None (0%)	None (0)
TEMS-03	12836705	285951	774.06	10/29/2011	14:10:00	48.0	46.1	0% (0 globules)	2.1	0.7	0.8	None	Light (15%)	Few (6)
TEMS-04	12836635	285971	775.42	10/29/2011	14:05:00	47.2	46.1	1% (0 globules)	1.7	0.8	1.1	Light	Light (3%)	Few (2)
TEMS-05	12836457	286048	775.53	10/29/2011	13:45:00	48.7	47.7	0% (0 globules)	2.6	0.9	1.3	None	Light (3%)	Few (2)
TEMS-06	12836339	286167	775.60	10/29/2011	14:27:00	51.1	48.2	40% (6 globules)	1.0	3.5	4.0	Moderate	Moderate (40%)	Few (4)
TEMS-07	12836240	286199	--	10/29/2011	13:35:00	47.4	47.4	1% (0 globule)	0.8	1.2	1.5	Light	Light (5%)	Few (4)
TEMS-08	12836358	286121	775.64	10/29/2011	14:22:00	49.5	48.7	0% (0 globules)	1.5	0.5	1.0	None	Light (7%)	Few (2)
TEMS-09	12836404	286091	775.47	10/29/2011	14:15:00	48.5	45.4	0 % (0 globules)	2.0	0.9	1.7	None	Light (1%)	None (0)

Table 3. Sediment and Water Temperatures Pre and Post Test
Enbridge Line 6B MP 608 Marshall, MI Pipeline Release
Enbridge Energy, Limited Partnership

Identification	Sediment Temperature	Water Temperature	Trial Temp. Study	Bath Water Temp.
Trial 1 Initial	38.3	38.1	35	*
Trial 1 Final	42.1	42.2	35	
Trial 2 Initial	36.7	37	35	
Trial 2 Final	39.3	39.5	35	
Trial 3 Initial	37.7	37.3	35	
Trial 3 Final	39.5	39.4	35	
Trial 1 Initial	45	43.3	45	46.6
Trial 1 Final	46.7	47.1	45	
Trial 2 Initial	46.1	45.5	45	
Trial 2 Final	47.2	47.9	45	
Trial 3 Initial	46.2	46	45	
Trial 3 Final	47.5	47.9	45	
Trial 1 Initial	56.6	55.2	55	49.5
Trial 1 Final	56.5	57.1	55	
Trial 2 Initial	55.7	56.4	55	
Trial 2 Final	56.8	57.5	55	
Trial 3 Initial	56.1	56.3	55	
Trial 3 Final	56.3	56.8	55	
Trial 1 Initial	64.4	65	65	57.4
Trial 1 Final	64.7	65.4	65	
Trial 2 Initial	66.5	66.9	65	
Trial 2 Final	66.2	67.1	65	
Trial 3 Initial	67	66.8	65	
Trial 3 Final	66.5	66.9	65	
Trial 1 Initial	74.6	75.1	75	76.2
Trial 1 Final	73.7	73.9	75	
Trial 2 Initial	76.2	76	75	
Trial 2 Final	74.6	75.2	75	
Trial 3 Initial	76.1	75.3	75	
Trial 3 Final	74.5	74.5	75	

* = The 35 degree tests were taken directly from cold storage at 35 degrees. The water bath was not used.

Table 4. Sheen Observation Results and Calculated Percents
Enbridge Line 6B MP 608 Marshall, MI Pipeline Release
Enbridge Energy, Limited Partnership

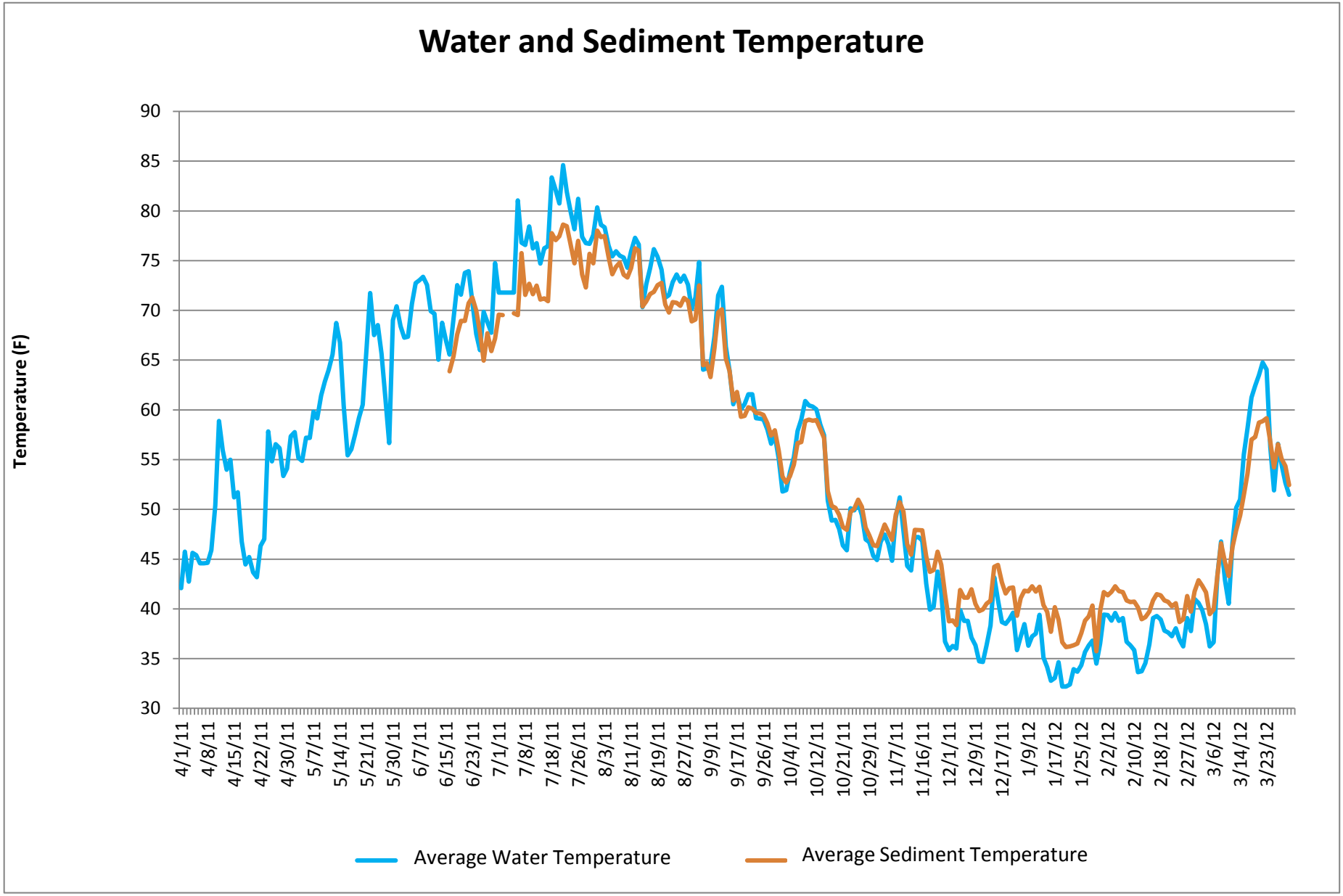
ArcID	Temp	Beaker	Stir	Sheen Area	Observation Area	Percent Sheen
35_1_1_Sheen	35	1	1	3.066886	26.247607	11.68%
35_1_3_Sheen	35	1	3	0.095593	26.247607	0.36%
35_1_0_Sheen	35	1	0	0	26.247607	0.00%
35_2_1_Sheen	35	2	1	0.035878	26.247607	0.14%
35_2_3_Sheen	35	2	3	0	26.247607	0.00%
35_2_0_Sheen	35	2	0	1.774794	26.247607	6.76%
35_3_1_Sheen	35	3	1	0.137452	26.247607	0.52%
35_3_3_Sheen	35	3	3	0	26.247607	0.00%
35_3_0_Sheen	35	3	0	3.134594	26.247607	11.94%
45_1_1_Sheen	45	1	1	0.269451	26.247607	1.03%
45_1_3_Sheen	45	1	3	0.096116	26.247607	0.37%
45_1_0_Sheen	45	1	0	4.053126	26.247607	15.44%
45_2_1_Sheen	45	2	1	0.701562	26.247607	2.67%
45_2_3_Sheen	45	2	3	0	26.247607	0.00%
45_2_0_Sheen	45	2	0	0.479814	26.247607	1.83%
45_3_1_Sheen	45	3	1	0.527989	26.247607	2.01%
45_3_3_Sheen	45	3	3	0.444053	26.247607	1.69%
45_3_0_Sheen	45	3	0	2.338752	26.247607	8.91%
55_1_1_Sheen	55	1	1	0	26.247607	0.00%
55_1_3_Sheen	55	1	3	0.242319	26.247607	0.92%
55_1_0_Sheen	55	1	0	1.973563	26.247607	7.52%
55_2_1_Sheen	55	2	1	0.327193	26.247607	1.25%
55_2_3_Sheen	55	2	3	0.16817	26.247607	0.64%
55_2_0_Sheen	55	2	0	8.94687	26.247607	34.09%
55_3_1_Sheen	55	3	1	2.631587	26.247607	10.03%
55_3_3_Sheen	55	3	3	1.21639	26.247607	4.63%
55_3_0_Sheen	55	3	0	4.149861	26.247607	15.81%
65_1_1_Sheen	65	1	1	0.225639	26.247607	0.86%
65_1_3_Sheen	65	1	3	1.20274	26.247607	4.58%
65_1_0_Sheen	65	1	0	2.347425	26.247607	8.94%
65_2_1_Sheen	65	2	1	1.945788	26.247607	7.41%
65_2_3_Sheen	65	2	3	1.339678	26.247607	5.10%
65_2_0_Sheen	65	2	0	4.811176	26.247607	18.33%
65_3_1_Sheen	65	3	1	1.50285	26.247607	5.73%
65_3_3_Sheen	65	3	3	2.331382	26.247607	8.88%
65_3_0_Sheen	65	3	0	0.98164	26.247607	3.74%
75_1_1_Sheen	75	1	1	3.58593	26.247607	13.66%
75_1_3_Sheen	75	1	3	4.94843	26.247607	18.85%
75_1_0_Sheen	75	1	0	5.126516	26.247607	19.53%
75_2_1_Sheen	75	2	1	3.3342	26.247607	12.70%
75_2_3_Sheen	75	2	3	9.57967	26.247607	36.50%
75_2_0_Sheen	75	2	0	6.980879	26.247607	26.60%
75_3_1_Sheen	75	3	1	1.734599	26.247607	6.61%
75_3_3_Sheen	75	3	3	4.945662	26.247607	18.84%
75_3_0_Sheen	75	3	0	4.149526	26.247607	15.81%

Table 5. Globule Observation Results and Calculated Percents
Enbridge Line 6B MP 608 Marshall, MI Pipeline Release
Enbridge Energy, Limited Partnership

ArcID	Temp	Beaker	Stir	Globule Area	Observation Area	Percent Sheen
35_1_1_Globules	35	1	1	0.01695	26.247607	0.06%
35_1_3_Globules	35	1	3	0	26.247607	0.00%
35_1_0_Globules	35	1	0	0	26.247607	0.00%
35_2_1_Globules	35	2	1	0	26.247607	0.00%
35_2_3_Globules	35	2	3	0	26.247607	0.00%
35_2_0_Globules	35	2	0	0	26.247607	0.00%
35_3_1_Globules	35	3	1	0	26.247607	0.00%
35_3_3_Globules	35	3	3	0	26.247607	0.00%
35_3_0_Globules	35	3	0	0	26.247607	0.00%
45_1_1_Globules	45	1	1	0	26.247607	0.00%
45_1_3_Globules	45	1	3	0	26.247607	0.00%
45_1_0_Globules	45	1	0	0.005963	26.247607	0.02%
45_2_1_Globules	45	2	1	0	26.247607	0.00%
45_2_3_Globules	45	2	3	0	26.247607	0.00%
45_2_0_Globules	45	2	0	0	26.247607	0.00%
45_3_1_Globules	45	3	1	0	26.247607	0.00%
45_3_3_Globules	45	3	3	0	26.247607	0.00%
45_3_0_Globules	45	3	0	0.009996	26.247607	0.04%
55_1_1_Globules	55	1	1	0	26.247607	0.00%
55_1_3_Globules	55	1	3	0	26.247607	0.00%
55_1_0_Globules	55	1	0	0.007766	26.247607	0.03%
55_2_1_Globules	55	2	1	0.007865	26.247607	0.03%
55_2_3_Globules	55	2	3	0.004323	26.247607	0.02%
55_2_0_Globules	55	2	0	0.00994	26.247607	0.04%
55_3_1_Globules	55	3	1	0.013114	26.247607	0.05%
55_3_3_Globules	55	3	3	0.014147	26.247607	0.05%
55_3_0_Globules	55	3	0	0.010871	26.247607	0.04%
65_1_1_Globules	65	1	1	0.003056	26.247607	0.01%
65_1_3_Globules	65	1	3	0.009939	26.247607	0.04%
65_1_0_Globules	65	1	0	0.010134	26.247607	0.04%
65_2_1_Globules	65	2	1	0.017258	26.247607	0.07%
65_2_3_Globules	65	2	3	0.003581	26.247607	0.01%
65_2_0_Globules	65	2	0	0.007858	26.247607	0.03%
65_3_1_Globules	65	3	1	0.005142	26.247607	0.02%
65_3_3_Globules	65	3	3	0.021938	26.247607	0.08%
65_3_0_Globules	65	3	0	0.014269	26.247607	0.05%
75_1_1_Globules	75	1	1	0.02612	26.247607	0.10%
75_1_3_Globules	75	1	3	0.011015	26.247607	0.04%
75_1_0_Globules	75	1	0	0.019614	26.247607	0.07%
75_2_1_Globules	75	2	1	0.009743	26.247607	0.04%
75_2_3_Globules	75	2	3	0.055199	26.247607	0.21%
75_2_0_Globules	75	2	0	0.020445	26.247607	0.08%
75_3_1_Globules	75	3	1	0.009738	26.247607	0.04%
75_3_3_Globules	75	3	3	0.0327	26.247607	0.12%
75_3_0_Globules	75	3	0	0.020261	26.247607	0.08%

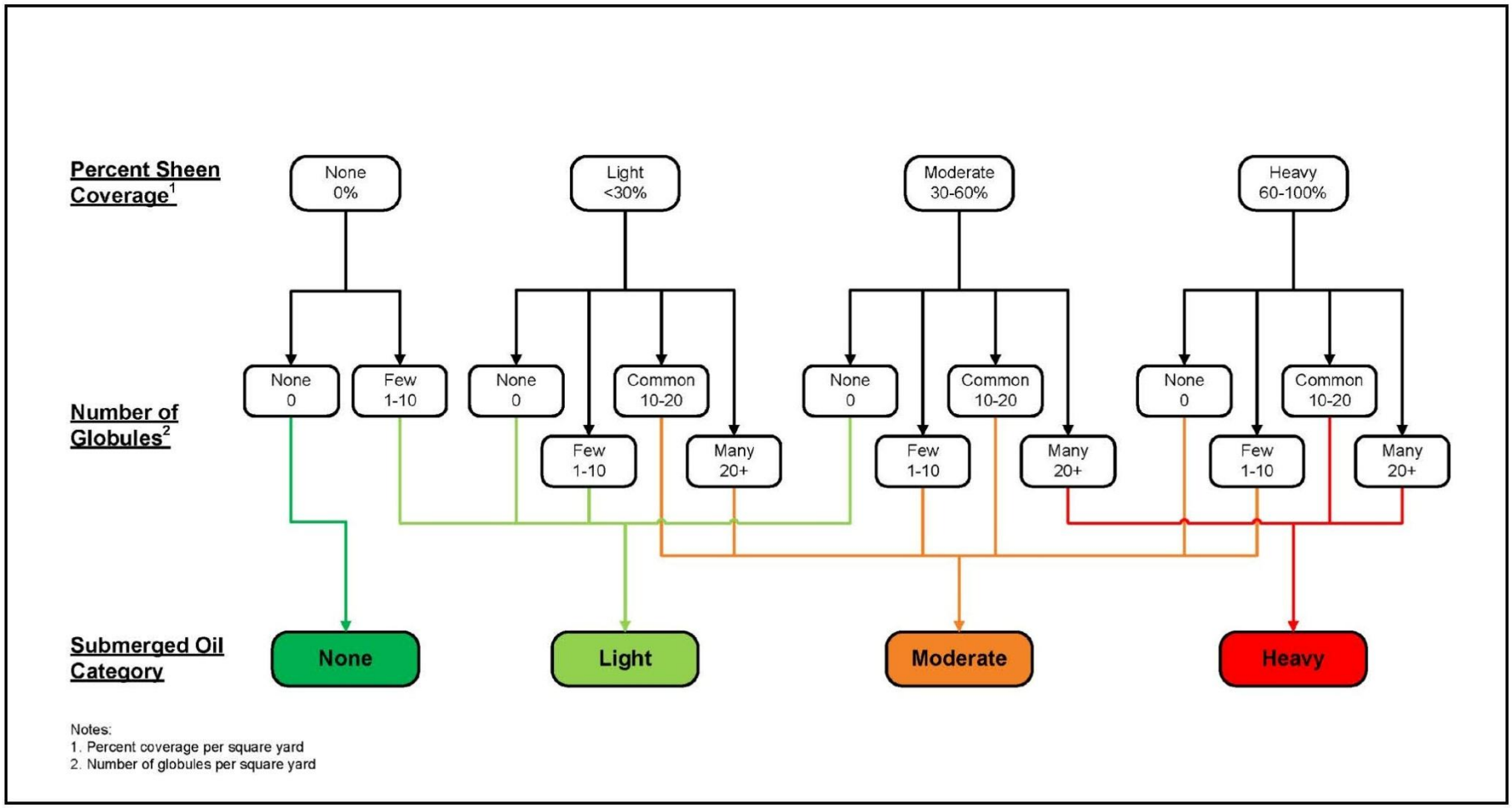
Attachment A

Historical Daily Water and Sediment Temperature



Attachment B

Submerged Oil Observation Flow Chart



Attachment C

Field Notes

Location MARSHALL, MI Date 12/19/11

Project / Client ENBRIDGE LINE 6B / ENBRIDGE

60162278 42° CLOUDY

1010 CJS ON-SITE @ 10.75 CHANNEL TO INITIATE SEDIMENT STUDY (TEMPERATURE EFFECTS ON SUB. OIL.
SET UP SHANTY OTHER EQUIPMENT.
AECOM ON-SITE:
DAVE DRYBURGH
CRAIG SIMON
RUSSELL PLATTE
MATT SUMNER
JOHN SVARK
WESTON EPA:
TIM LAQUERRE

1026 AECOM BEGIN POLING TO FIND "DIRTY" SEDIMENT LOCATION.
TEMPERATURE @ SAMPLE LOCATION
43.1°F (SEDIMENT)
40.5°F (H_2O IMMEDIATELY ABOVE SEDIMENT)
FRCE OIL & SHEEN VISIBLE IN SONAR SAMPLE AND ON H_2O SURFACE.

1140 2 5-GAL BUCKETS ~ 1/3-1/2 FULL COLLECTED SO FAR.
42.7°F SEDIMENT
40.1°F H_2O
WILL TAKE TEMP READINGS AFTER EACH

Location MARSHALL, MI Date 12/19/11

Project / Client ENBRIDGE LINE 6B / ENBRIDGE

60162278 44° CLOUDY

1100 cont. BUCKET IS FILLED W/ SUFFICIENT VOLUME.
43.9°F SEDIMENT
40.5°F H_2O

1123 4 BUCKETS FILLED SO FAR.
43.1°F SEDIMENT TEMP.
40.5°F H_2O TEMP.

1131 5 BUCKETS FILLED
43.3°F SEDIMENT TEMP
40.8°F H_2O TEMP

1135 COLLECT 3 5-GAL BUCKETS OF SHEEN FREE RIVER H_2O.

1140 COLLECT POLYGON ON YUMA # 14 OF SAMPLE LOCATIONS - ALL SAMPLES TAKEN FROM ~ 10' RADIUS.

1200 UV LIGHT DESCRIPTION:
BUCKET #1: ~ 50-60% OF H_2O SURFACE IN FLUORESCING MATERIAL. SOME VISIBLE FREE OIL DION'T FLUORESCE @ ALL. GLOBES UP TO 0.5" DIAMETER.
BUCKET #2: ~ 5% OF H_2O SURFACE COVERED W/ FLUORESCING MATERIAL. ~ 10 GLOBS MEASURING LESS THAN 1/8" DIAM.
BUCKET #3 ~ 30-40% OF H_2O SURFACE COVERED IN FLUORESING MATERIAL. GLOBS < 1/2" DIAMETER.

Location MARSHALL, MI Date 12/19/11

Project / Client ENBRIDGE LINE 6B / ENBRIDGE

6@1162778 45° PART SUN

1200 CONT'D BUCKET #4: ~5% OF SURFACE OF H_2O COVERED IN FLUORESCING MATERIAL. GLOBS LESS THAN 1/8" DIAMETER.
BUCKET #5: ~50% OF H_2O SURFACE COVERED IN FLUORESCING MATERIAL. GLOBS ~1/2 - 5/8" DIAMETER.

1230 VISIBLE LIGHT DESCRIPTION OF EACH BUCKET:
BUCKET #1: HEAVY SHEEN, ON H_2O GLOBULES PRESENT, 1-2" H_2O PRESENT ON TOP OF SED.
BUCKET #2: LIGHT SHEEN, 5-10 VERY SMALL GLOBS (. SIZE) PRESENT. ~1/2" H_2O PRESENT ON TOP OF SEDIMENT.
BUCKET #3: HEAVY SHEEN ON H_2O, MANY GLOBULES PRESENT. 1/2" H_2O PRESENT ON TOP OF SEDIMENT.
BUCKET #4: LIGHT TO MODERATE SHEEN, SEVERAL SMALLISH (1/8") GLOBULES PRESENT ~1/2" H_2O PRESENT ON TOP OF SEDIMENT.
BUCKET #5: HEAVY SHEEN ON H_2O, MANY GLOBULES PRESENT. ~1/4" H_2O ON TOP OF SEDIMENT.

1250 WILL ADD ~1 GAL H_2O TO BUCKETS 4 & 5 AND AGITATE W/ POLING ROD.

Location MARSHALL, MI Date 12/19/11

Project / Client ENBRIDGE LINE 6B / ENBRIDGE

6@1162778 45° PART SUN

1300 POST AGITATION RESULTS INDICATE A HEAVY SHEEN W/ MANY GLOBULES IN BOTH BUCKETS 4 AND 5.

1435 ON-SITE @ CONFLUENCE GARAGE. BEGIN COMPOSITING SEDIMENT FROM ALL 3 BUCKETS INTO 15 NALGENE PLASTIC BEAKERS (3 EACH FOR 5 DIFFERENT TEMPERATURE TRIALS).

1500 COMPOSITING COMPLETE. JOHN STARK TO COMPOSITE SEDIMENT FROM EACH OF 3 BUCKETS INTO ALUMINUM PAN TO CLASSIFY SOIL & COLLECT SOIL FOR LAB ANALYSIS.

1515 LAB SAMPLES COLLECTED & SEDIMENT CLASSIFIED.
BEGIN POURING ENOUGH RIVER H_2O INTO EACH BEAKER TO 1,500 ML OF COMBINED SED & H_2O IN EACH. H_2O POURED VERY GENTLY INTO EACH BEAKER W/OUT AGITATING SEDIMENT.

1550 EACH BEAKER SEALED W/ SARAN WRAP & RUBBER BAND.

1615 ALL SEDIMENT PLACED INTO REFRIGERATORS SET @ ~35.5° F.

1630 OFF-SITE TO SUPERIOR TO LOG IN SAMPLE.

Attachment D

Grain Size Analytical Report

DRIESENGA & ASSOCIATES, INC.
Engineering · Surveying · Testing

455 East 8th Street, Suite 100
Holland, Michigan 49423
Ph. (616) 396-0255 • Fax (616) 396-0100
www.driesenga.com

TRANSMITTAL

TO:	ALS Group USA, Corp 3352 128th Avenue Holland, Michigan 49424		**DATE:**	December 28, 2011
ATTN:	Ann Preston		**PROJECT:**	Lab Testing – ALS #1112667
WE ARE TRANSMITTING:	☒	**HEREWITH**	☐	**UNDER SEPARATE COVER**

QUANTITY	DESCRIPTION
One (1) One (1)	12-28-11 Particle Size Analysis of Soils (ASTM D422 w/ Hydrometer) 12-20-11 ALS Chain of Custody Record

ISSUED FOR:	☐	**APPROVAL**	☐	**REVIEW & COMMENT**
	☐	**INFORMATION**	☐	**CONSTRUCTION**
	☒	**YOUR FILE**	☐	**AS REQUESTED**

REMARKS:	Please contact me with any questions.
DISTRIBUTION:	File – 1110246.4A

By: James Henning

James Henning, P.E.
Division Manager

DRIESENGA & ASSOCIATES, INC.
Engineering · Surveying · Testing

455 East 8th Street, Suite 100
Holland, Michigan 49423
Ph. (616) 396-0255 • Fax (616) 396-0100
www.driesenga.com

PARTICLE-SIZE ANALYSIS OF SOILS

(ASTM D422)

Client Name: ALS Environmental

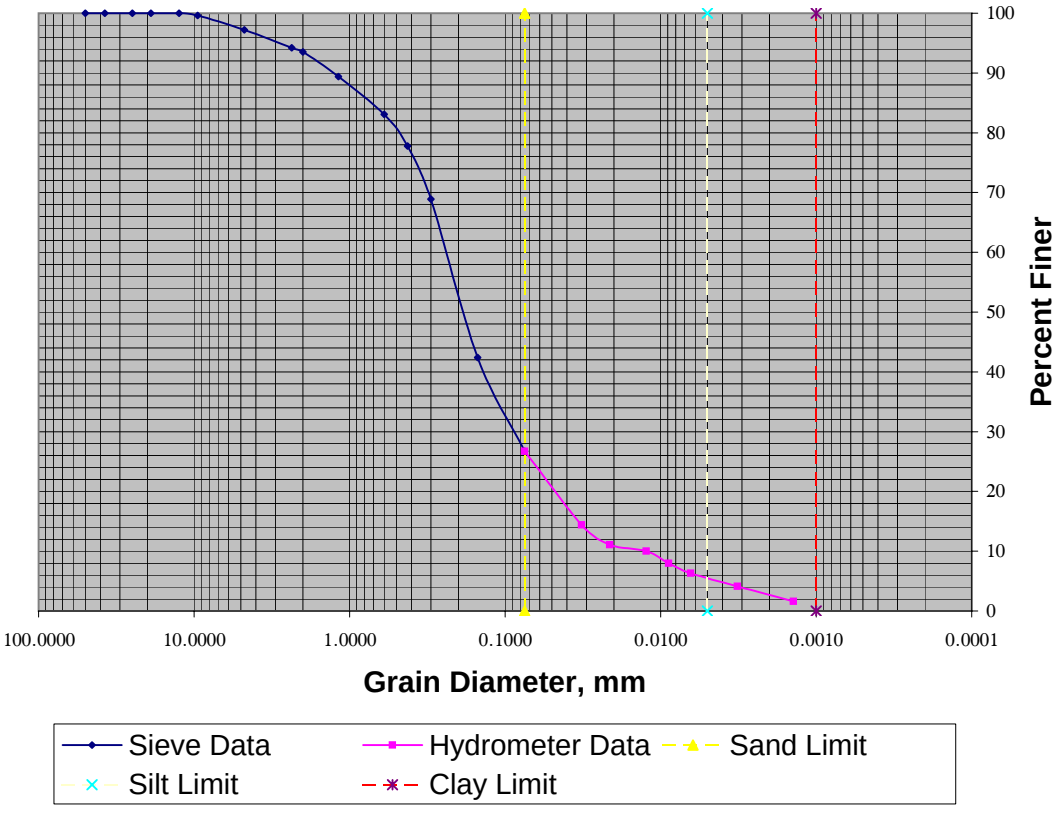
Project Name: Client #1112667 Project No.: 1110246.4A

Date: 12/28/2011 Technician: Michael Stork

Sample No: 01A

Soil Description: Dk. Brown Fine Sandy Muck, Some Organics (Root Fibers & Seashells), Trace Gravel

Sieve Analysis



Remarks:

ALS Environmental

Subcontractor:
Driesenga & Associates, Inc
455 8th Street
Suite 100
Holland, MI 49423

TEL: (616) 396-0255
FAX:
Acct #:

CHAIN-OF-CUSTODY RECORD

Date: 20-Dec-11
COC ID: 3367
Due Da 28-Dec-11

Salesperson: Alex Csaszar

Customer Information		Project Information		Parameter/Method Request for Analysis	
Purchase Order	20-1112667	Project Name	1112667	A	Subcontracted Analyses (SUBCONTRACT) Grain Size w/ hydrometer D422
Work Order		Project Number		B	
Company Name	ALS Group USA, Corp	Bill To Company	ALS Group USA, Corp	C	
Send Report To	Ann Preston	Inv Attn	Accounts Payable	D	
Address	3352 128th Avenue	Address	3352 128th Avenue	E	
				F	
City/State/Zip	Holland, Michigan 49424-9263	City/State/Zip	Holland, Michigan 49424-9263	G	
Phone	(616) 399-6070	Phone	(616) 399-6070	H	
Fax	(616) 399-6185	Fax	(616) 399-6185	I	
eMail Address	ann.preston@alsglobal.com	eMail CC		J	

Sample ID	Matrix	Collection Date 24hr	Bottle	A	B	C	D	E	F	G	H	I	J
1112667-01A	Sediment	19/Dec/2011 15:00	(1) 16OZGNEAT	X									

Comments:
Please analyze for Grain Size with hydrometer by ASTM D422. Email results to Ann Preston.

Relinquished by:	Date/Time	Received by:	Date/Time	Cooler IDs	Report/QC Level
	12/21/11 0900		12/21/11		Std
Relinquished by:	Date/Time	Received by:	Date/Time		

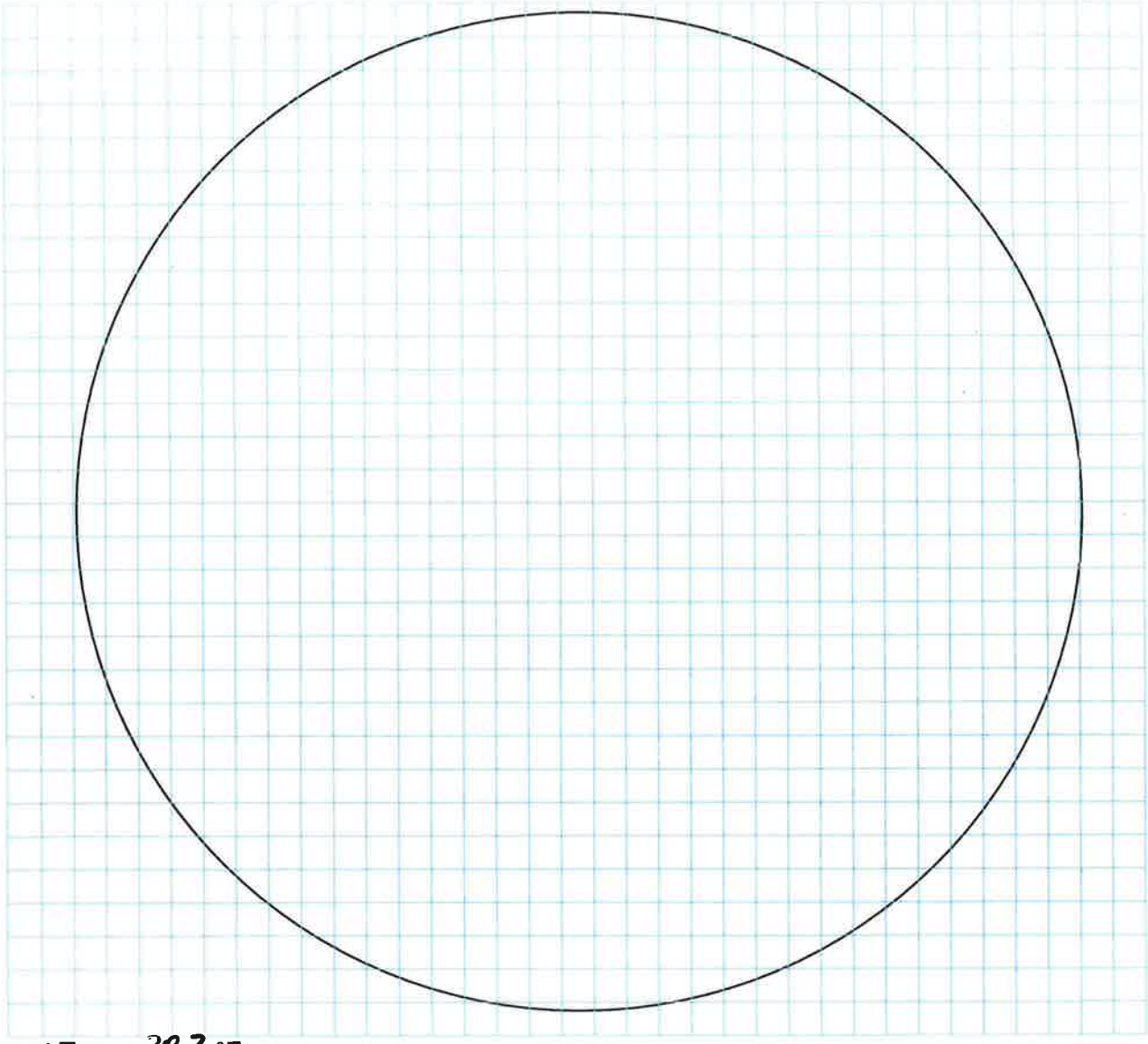
Attachment E

Observation Forms

Observation Form

Temperature: 35 °F
Beaker #: 1
Mile Post: 13.75

Observation:
- [x] Prior to agitation
- [ ] After 1 Stir
- [ ] After 3 stirs



Sediment Temp: 38.3 °F

Surface Water Temp: 38.1 °F

Visible Light Sheen:
- [x] None
- [ ] Gray
- [ ] Silver
- [ ] Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- [ ] None
- [ ] Fluoresced Oil
- [x] Fluoresced globules 2 PINHEAD SIZED

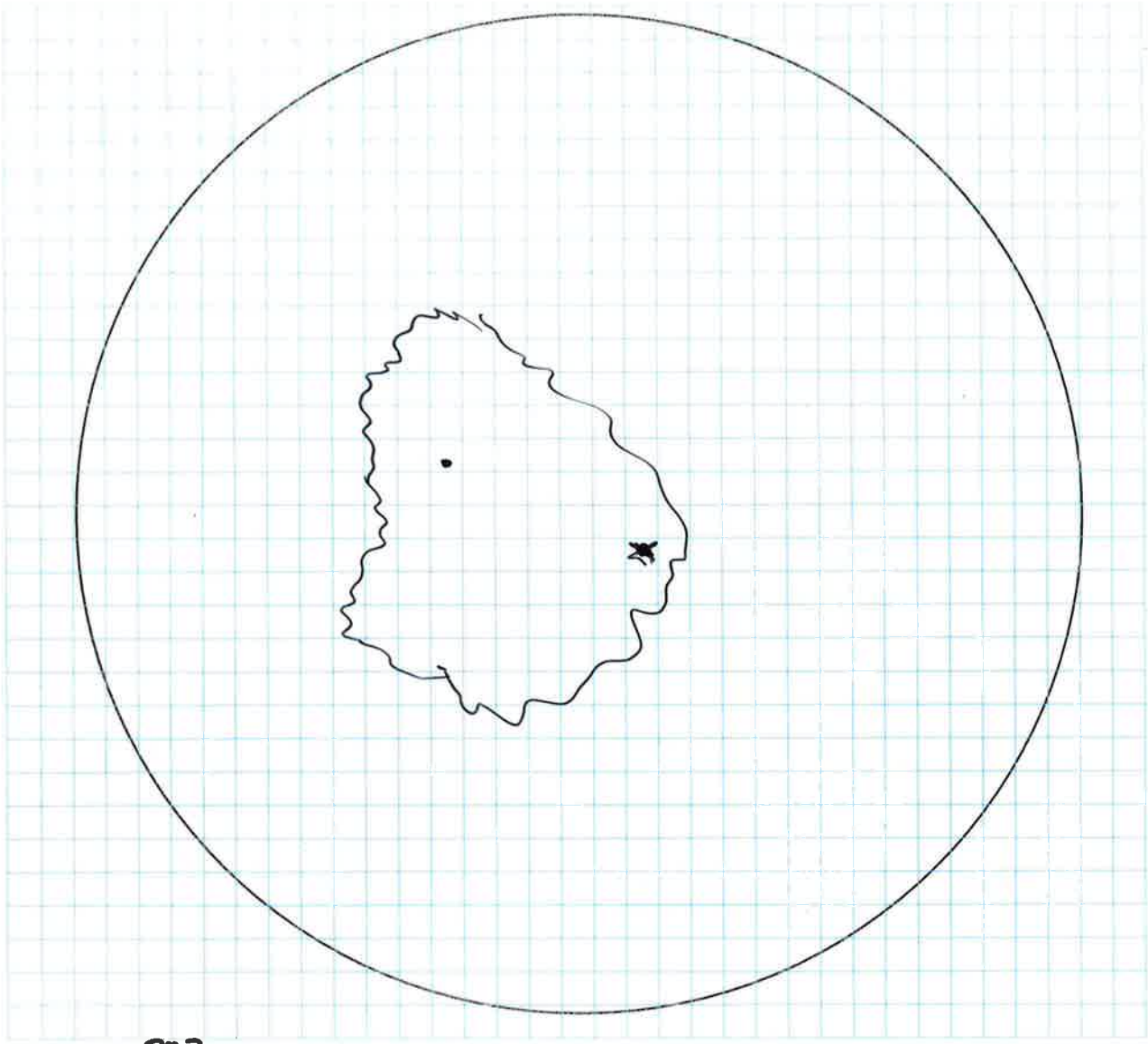
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: [signature] Date: 1/9/16

Observation Form

Temperature: 35 °F
Beaker #: 1
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☒ After 1 Stir
- ☐ After 3 stirs



Sediment Temp: 28.3 °F

Surface Water Temp: 38.1 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # 2
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☐ Fluoresced Oil
- ☒ Fluoresced globules

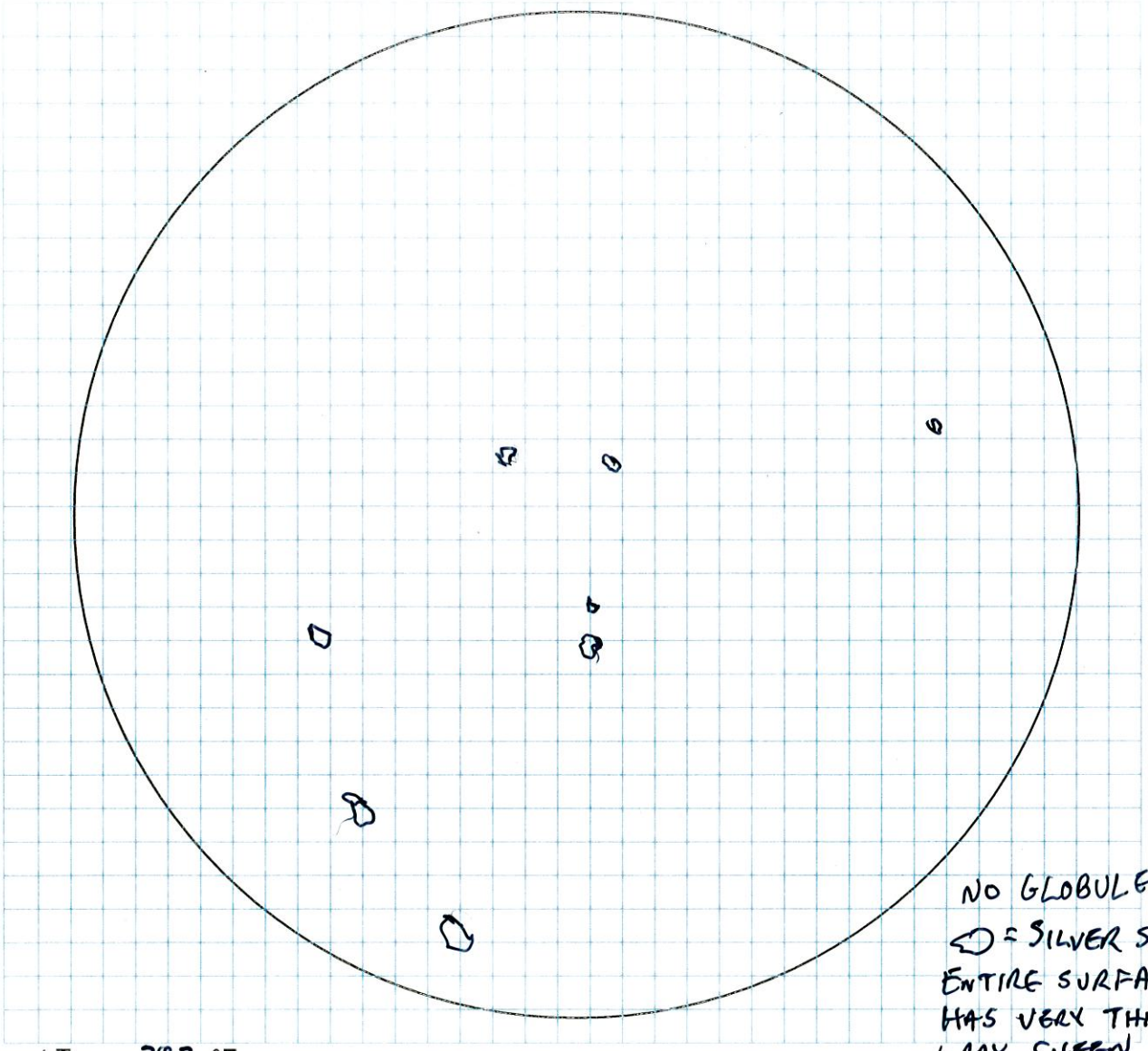
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/9/12

Observation Form

Temperature: 35 °F
Beaker #: 1
Mile Post: 16.75

Observation:
- ☐ Prior to agitation
- ☐ After 1 Stir
- ☒ After 3 stirs



NO GLOBULES
◇ = SILVER SHEEN
ENTIRE SURFACE HAS VERY THIN, GRAY SHEEN

Sediment Temp: 38.3 °F

Surface Water Temp: 38.1 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☒ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☐ Fluoresced Oil
- ☒ Fluoresced globules 2 PIN-HEAD SIZED GLOBULES

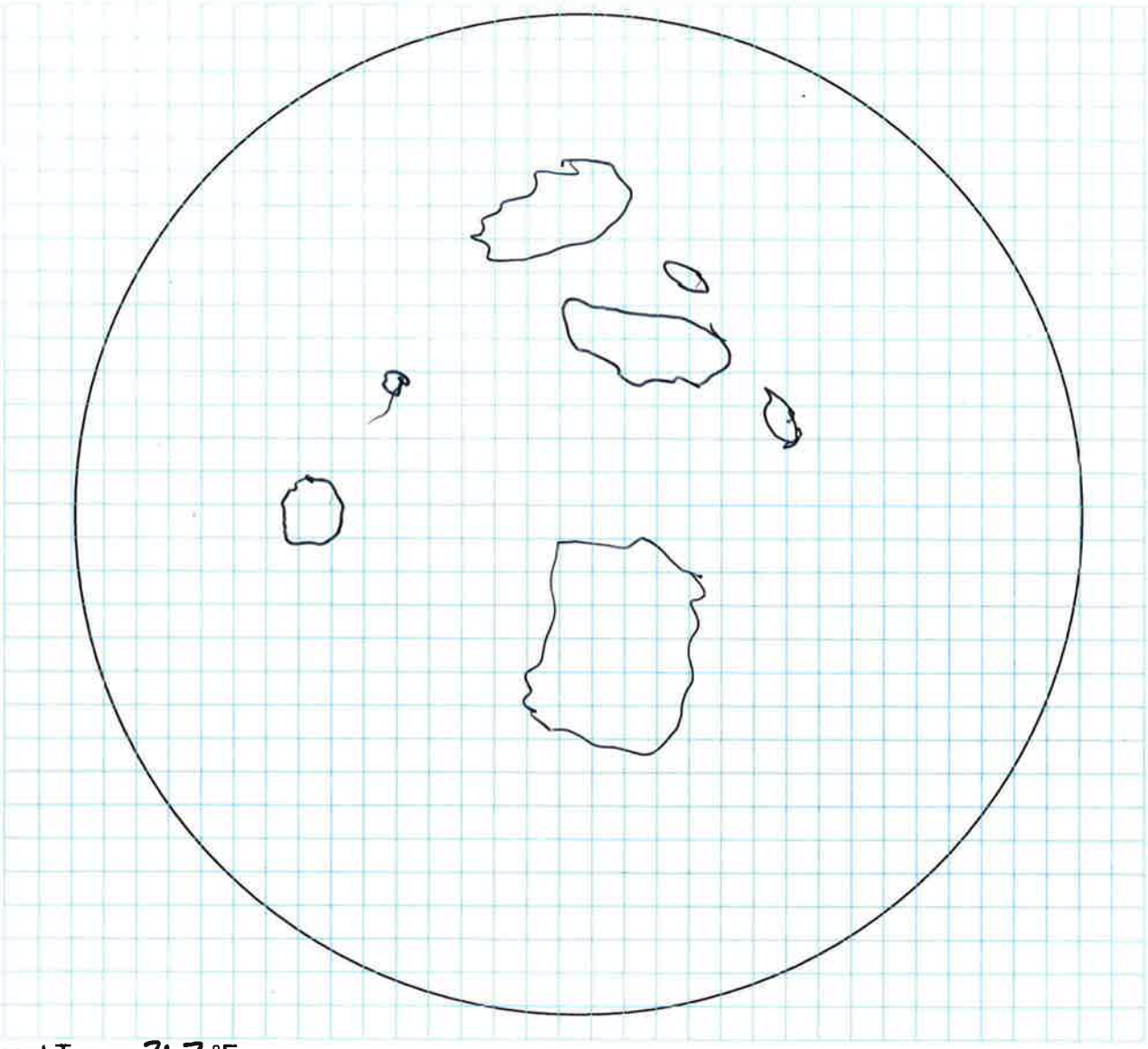
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/9/12

Observation Form

Temperature: 35 °F
Beaker #: 2
Mile Post: 10.75

Observation:
- [x] Prior to agitation
- [ ] After 1 Stir
- [ ] After 3 stirs



Sediment Temp: 36.7 °F

Surface Water Temp: 37.0 °F

Visible Light Sheen:
- [ ] None
- [x] Gray
- [ ] Silver
- [ ] Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- [x] None
- [ ] Fluoresced Oil
- [ ] Fluoresced globules

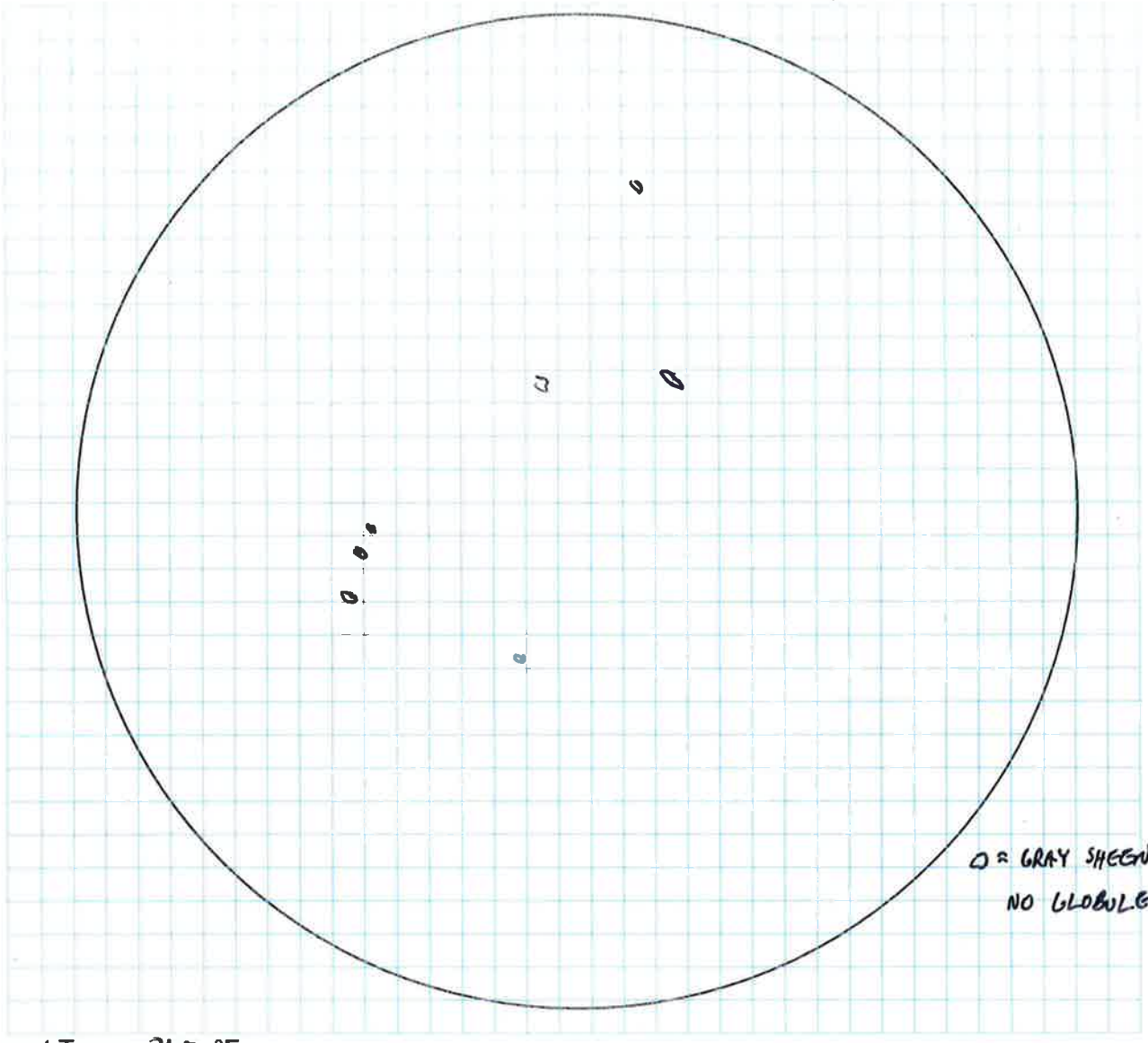
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: [signature] Date: 1/9/16

Observation Form

Temperature: 35 °F
Beaker #: 2
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☒ After 1 Stir
- ☐ After 3 stirs



Sediment Temp: 36.7 °F

Surface Water Temp: 37.0 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☒ None
- ☐ Fluoresced Oil
- ☐ Fluoresced globules

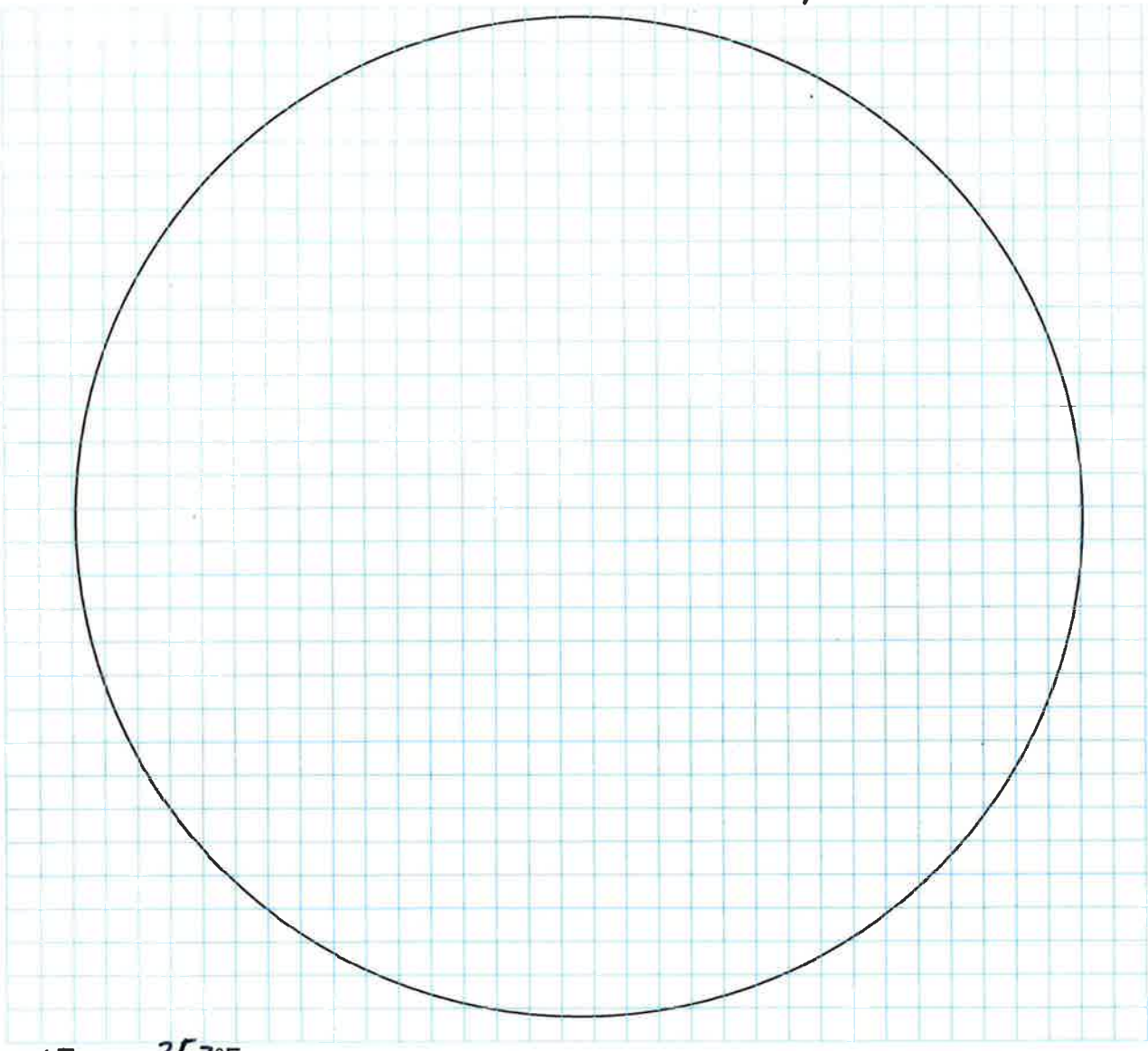
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/9/12

Observation Form

Temperature: 35 °F
Beaker #: 2
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☐ After 1 Stir
- ☒ After 3 stirs



Sediment Temp: 36.7 °F

Surface Water Temp: 37.0 °F

Visible Light Sheen:
- ☒ None
- ☐ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☒ None
- ☐ Fluoresced Oil
- ☐ Fluoresced globules

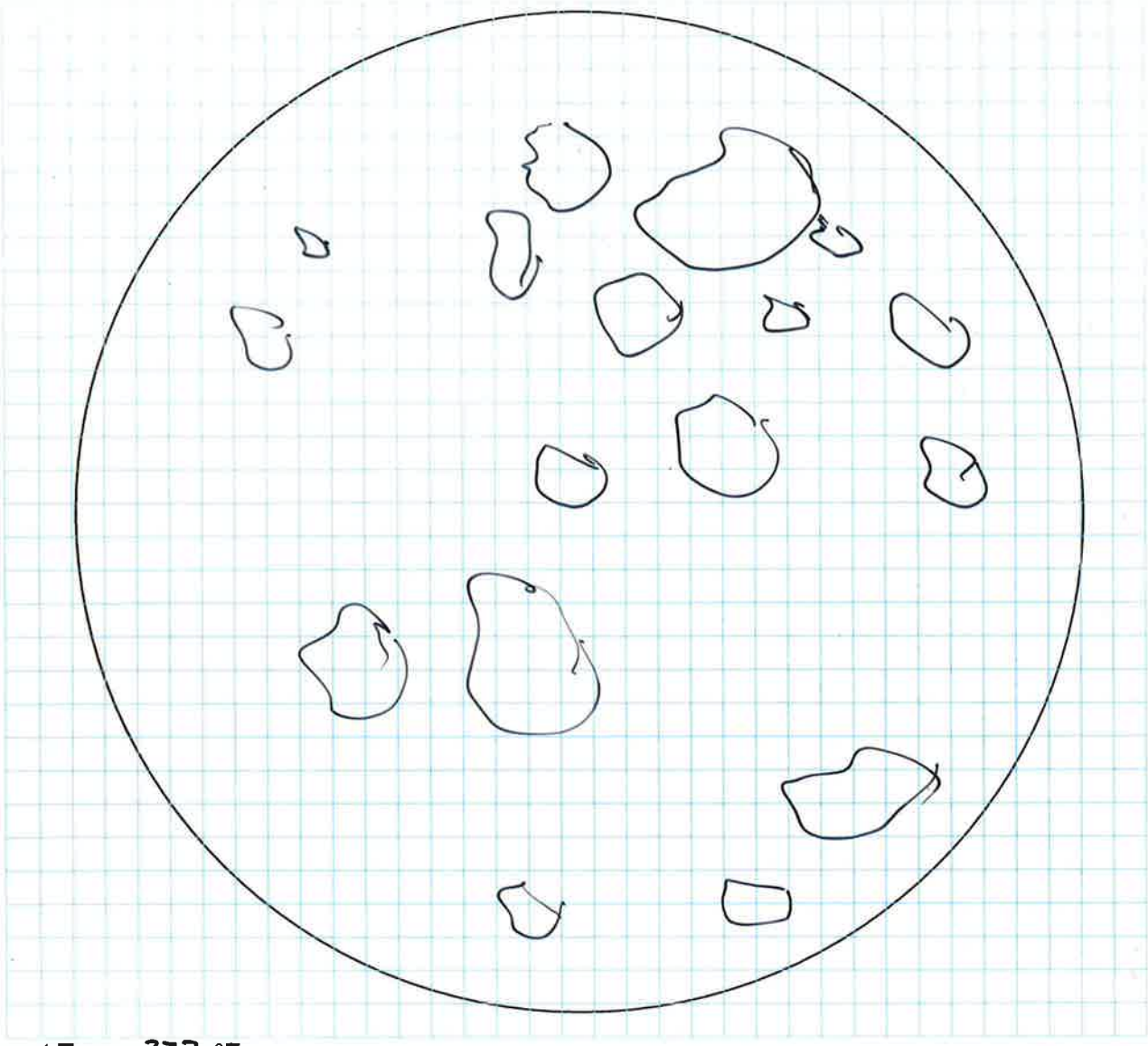
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 6/9/16

Observation Form

Temperature: 35 °F
Beaker #: 3
Mile Post: 10.75

Observation:
- ☒ Prior to agitation
- ☐ After 1 Stir
- ☐ After 3 stirs



Sediment Temp: 37.7 °F

Surface Water Temp: 37.3 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☐ Fluoresced Oil
- ☒ Fluoresced globules 4 PIN-HEAD SIZED GLOBULES

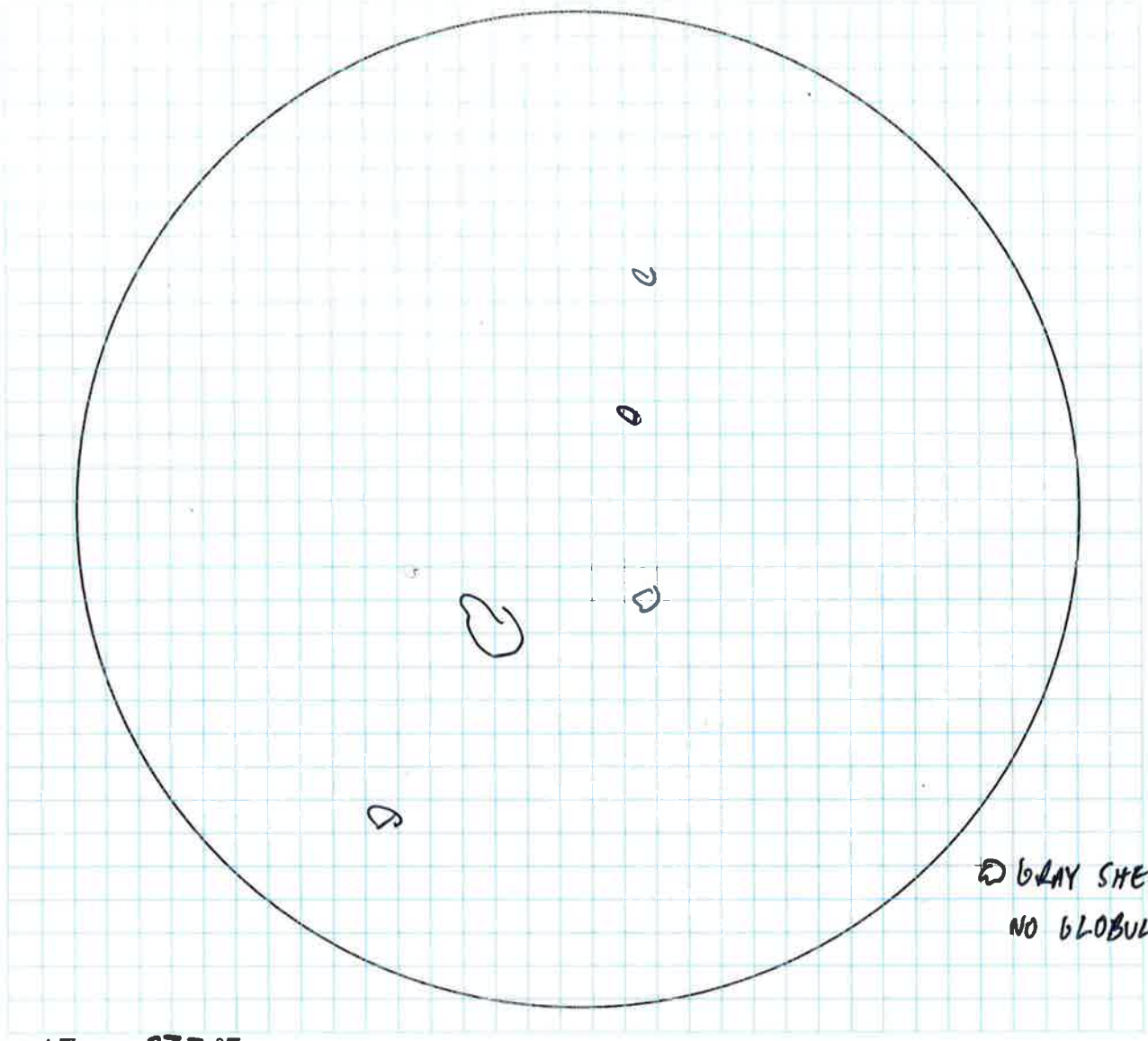
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/9/12

Observation Form

Temperature: 35 °F
Beaker #: 3
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☒ After 1 Stir
- ☐ After 3 stirs



Sediment Temp: 37.7 °F

Surface Water Temp: 37.3 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☒ None
- ☐ Fluoresced Oil
- ☐ Fluoresced globules

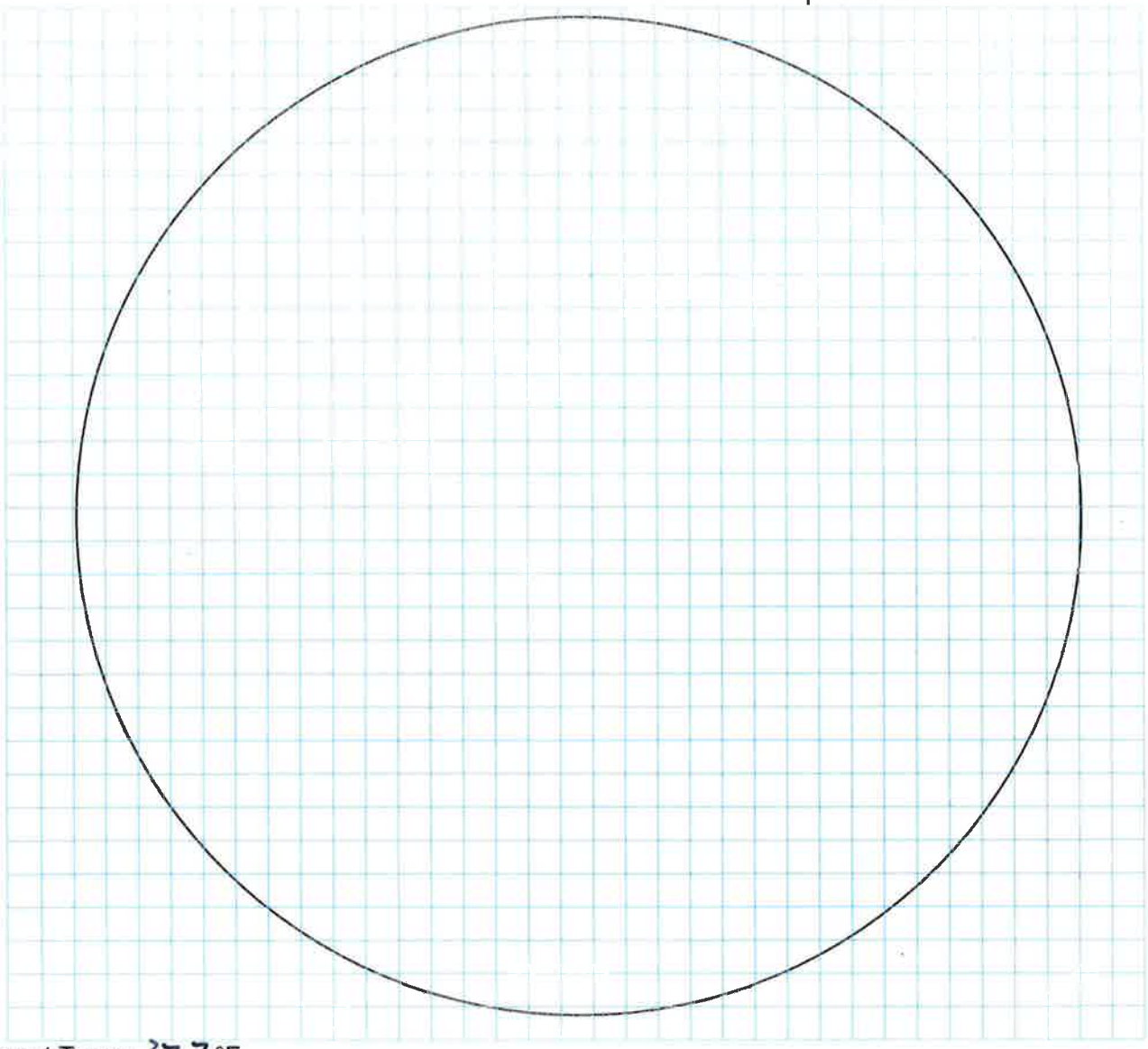
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/9/12

Observation Form

Temperature: 35 °F
Beaker #: 3
Mile Post: 16.75

Observation:
- ☐ Prior to agitation
- ☐ After 1 Stir
- ☒ After 3 stirs



Sediment Temp: 37.7 °F

Surface Water Temp: 37.3 °F

Visible Light Sheen:
- ☒ None
- ☐ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☒ None
- ☐ Fluoresced Oil
- ☐ Fluoresced globules

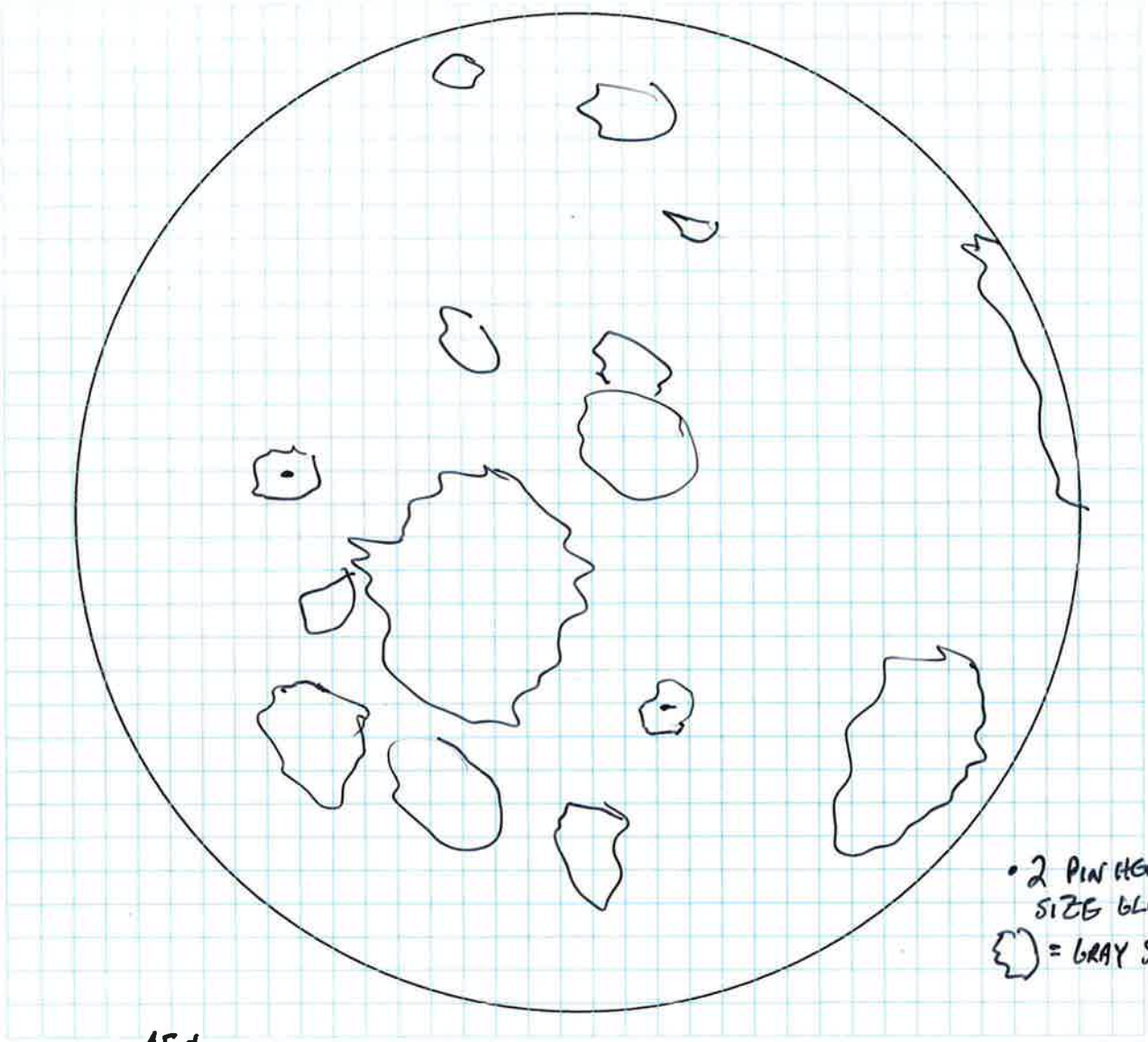
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: [signature] Date: 1/9/16

Observation Form

Temperature: 45 °F
Beaker #: 1
Mile Post: 10.75

Observation:
- [x] Prior to agitation
- [ ] After 1 Stir
- [ ] After 3 stirs



Sediment Temp: 45.0 °F

Surface Water Temp: 43.3 °F

Visible Light Sheen:
- [ ] None
- [x] Gray
- [ ] Silver
- [ ] Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Globules:
Count # _____
Ave. Dia.: _____ in.

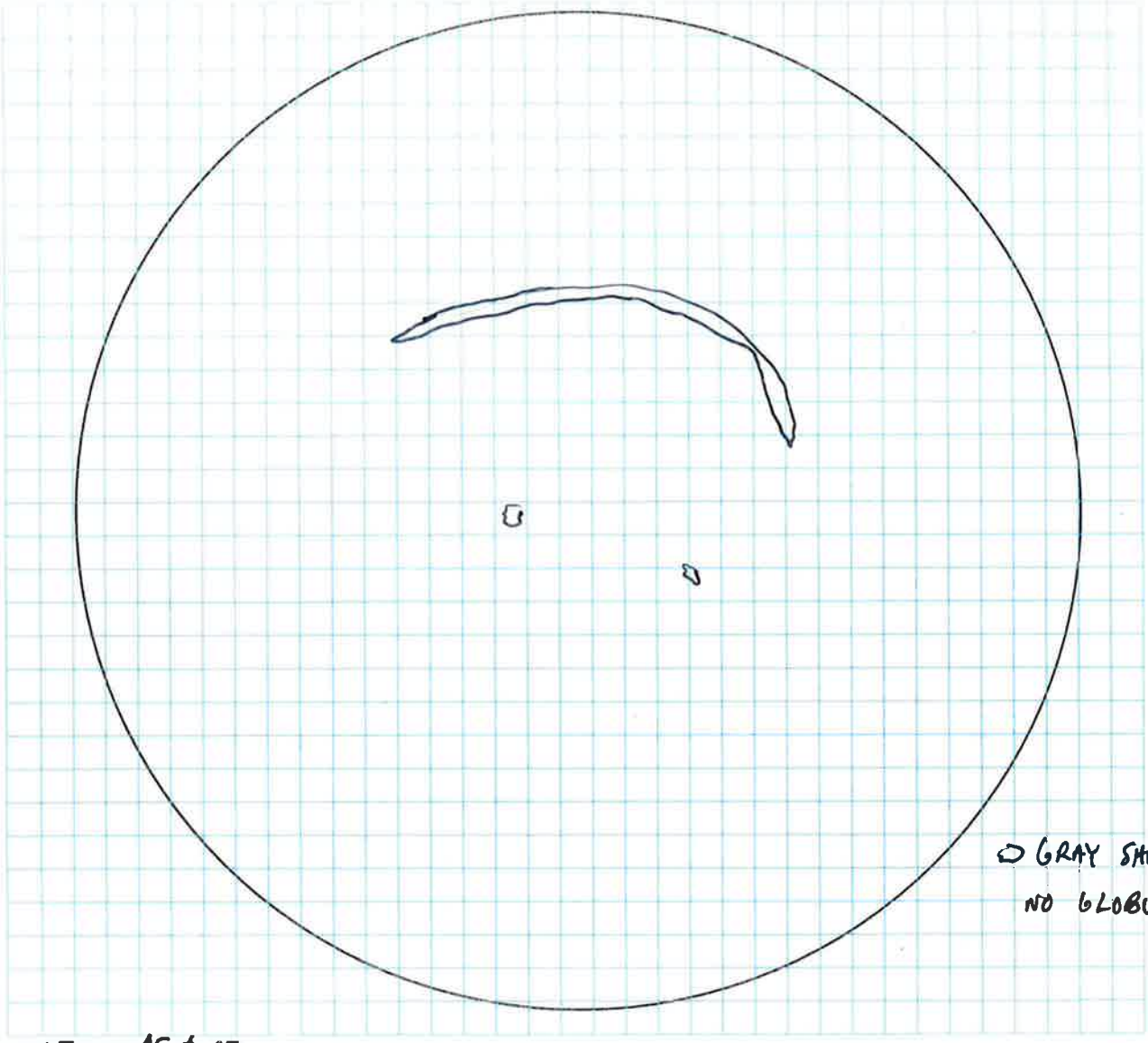
UV Light Sheen:
- [ ] None
- [x] Fluoresced Oil
- [x] Fluoresced globules 3 PIN HEAD SIZED GLOBULES

Sign Off: _____ Date: 1/9/12

Observation Form

Temperature: 45 °F
Beaker #: 1
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☒ After 1 Stir
- ☐ After 3 stirs



Sediment Temp: 45.0 °F

Surface Water Temp: 43.3 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☒ Fluoresced Oil SUBMERGED, ADHERED TO SIDE OF BEAKER ~ 1/8" BELOW SURFACE OF H_2O
- ☐ Fluoresced globules

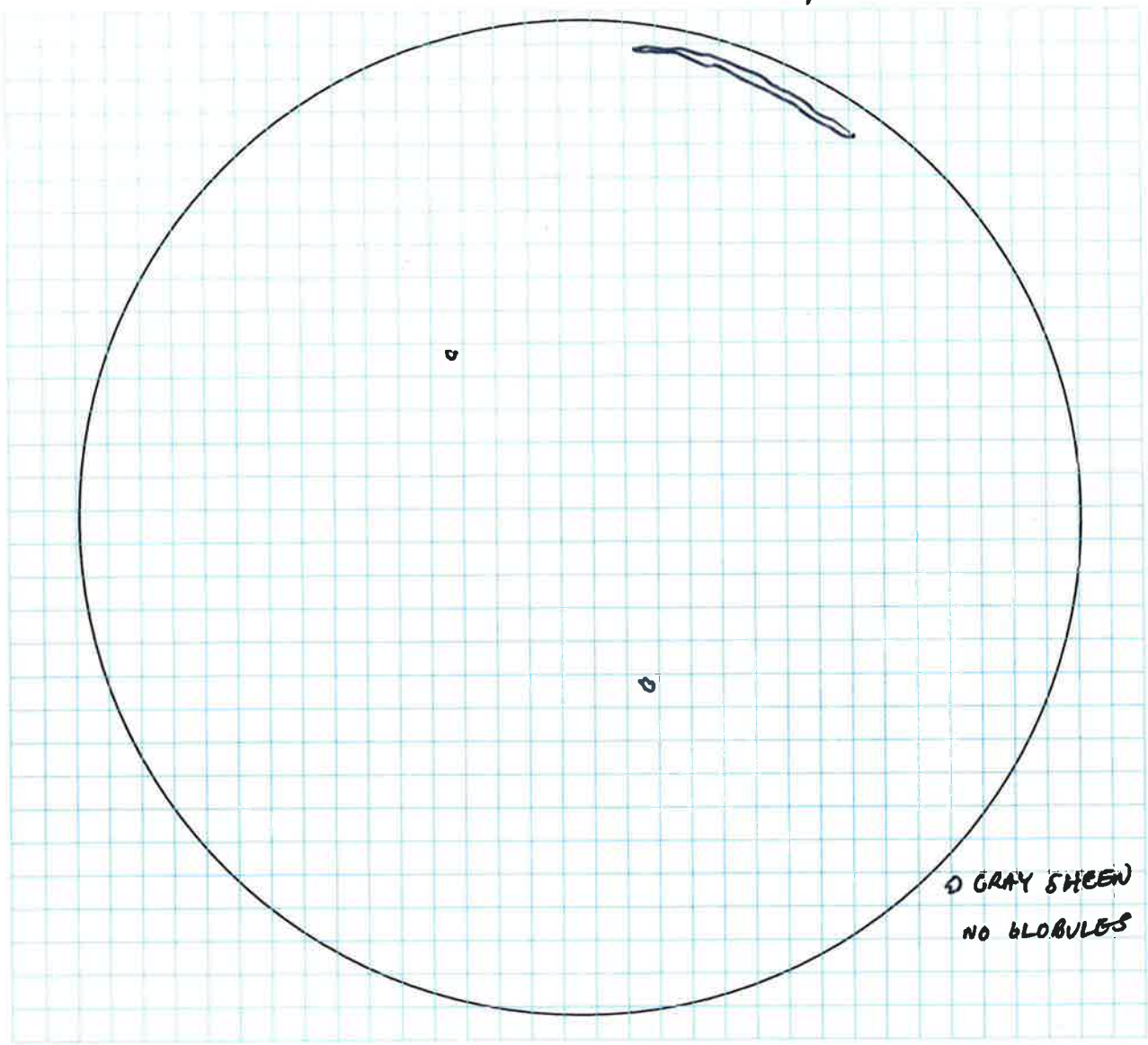
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: [signature] Date: 1/9/18

Observation Form

Temperature: 45 °F
Beaker #: 1
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☐ After 1 Stir
- ☒ After 3 stirs



Sediment Temp: 45.0 °F

Surface Water Temp: 43.3 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☒ None
- ☐ Fluoresced Oil
- ☐ Fluoresced globules

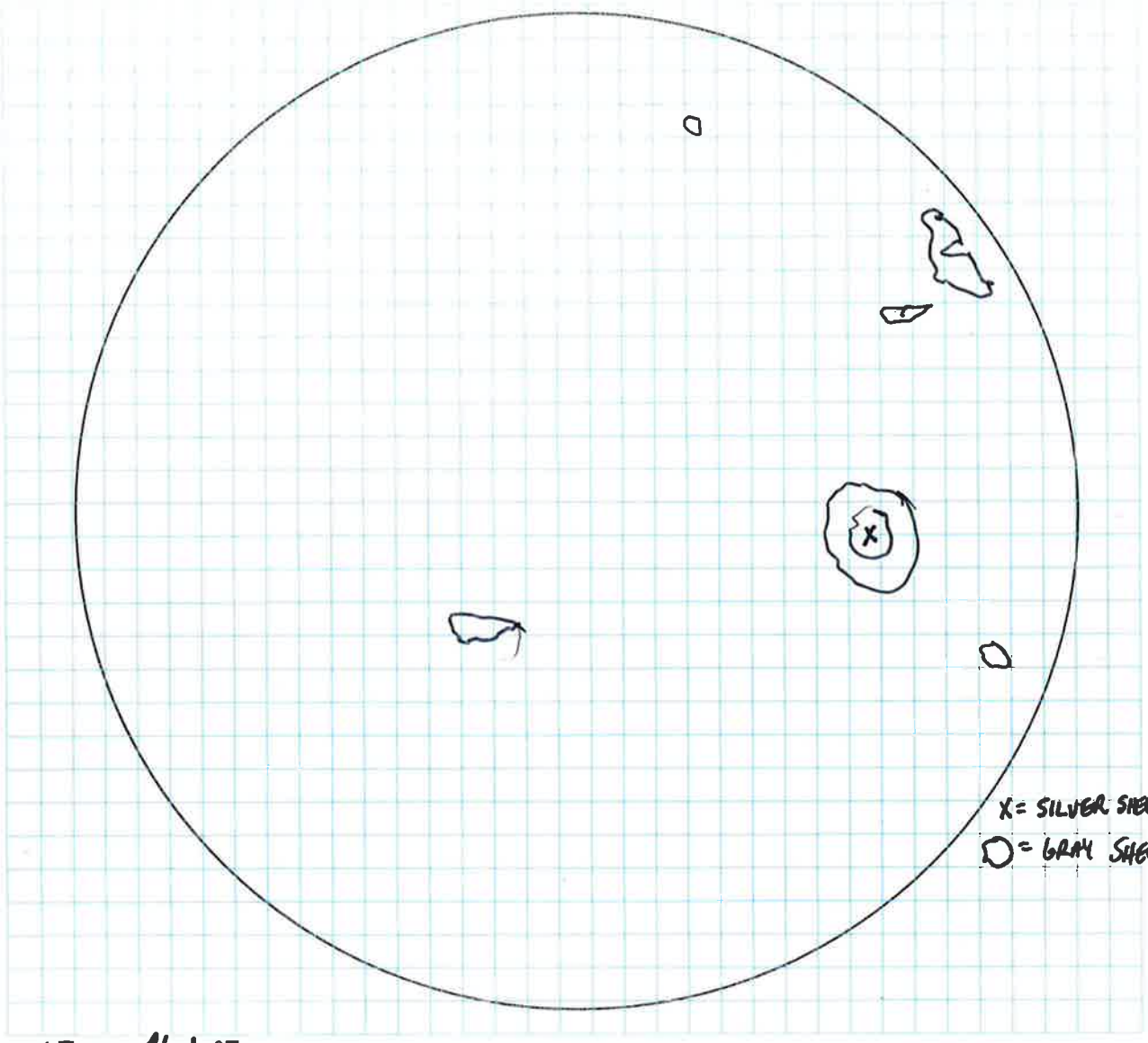
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: G. J. Lin Date: 1/9/12

Observation Form

Temperature: 45 °F
Beaker #: 2
Mile Post: 10.75

Observation:
- [x] Prior to agitation
- [ ] After 1 Stir
- [ ] After 3 stirs



Sediment Temp: 46.1 °F

Surface Water Temp: 45.5 °F

Visible Light Sheen:
- [ ] None
- [x] Gray
- [x] Silver
- [ ] Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- [ ] None
- [x] Fluoresced Oil 2 DIME SIZED AREAS
- [x] Fluoresced globules 2 PIN HEAD SIZED GLOBS

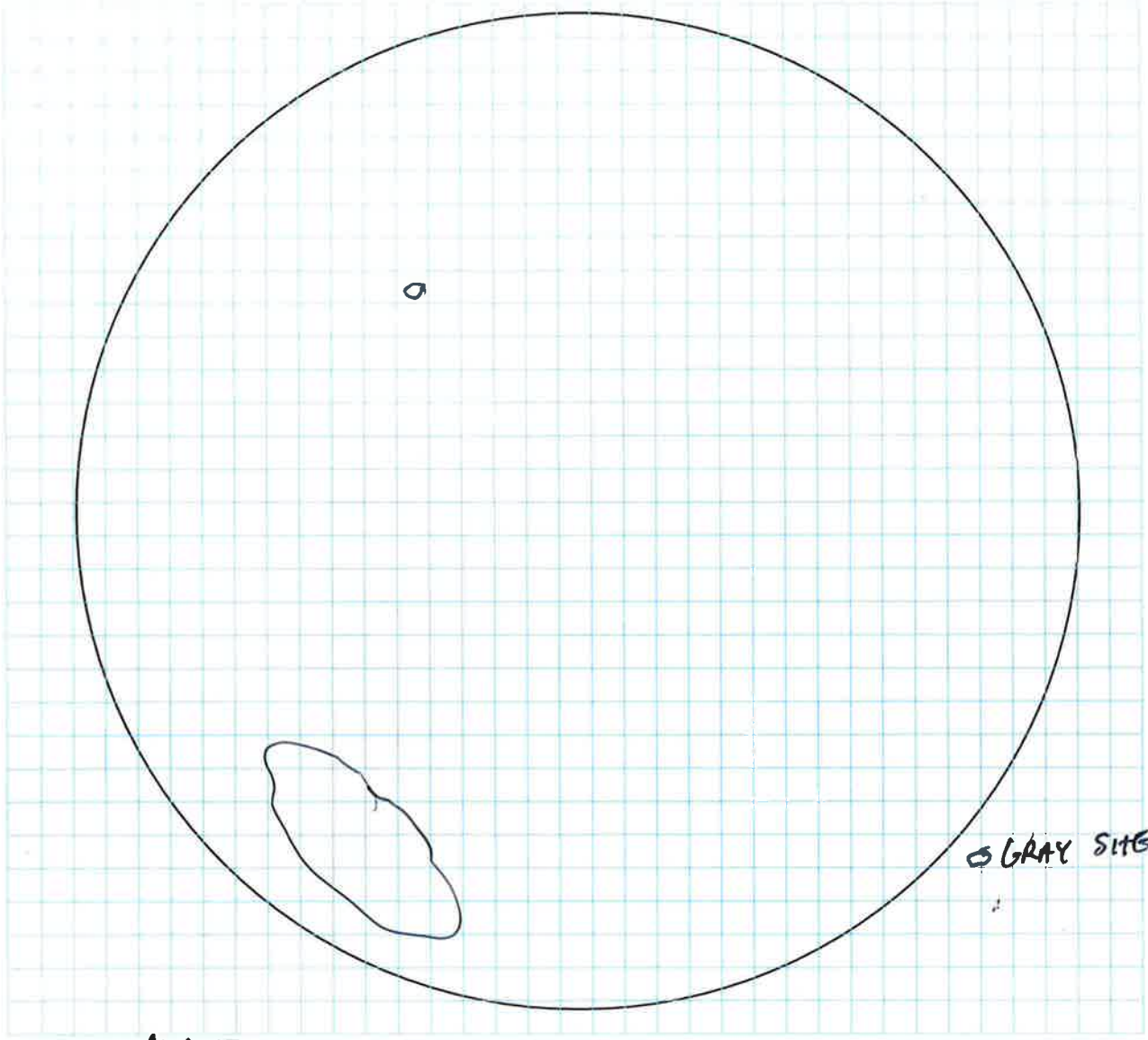
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/9/12

Observation Form

Temperature: 45 °F
Beaker #: 2
Mile Post: 10.25

Observation:
- ☐ Prior to agitation
- ☒ After 1 Stir
- ☐ After 3 stirs



Sediment Temp: 46.1 °F

Surface Water Temp: 45.5 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☒ None
- ☐ Fluoresced Oil
- ☐ Fluoresced globules

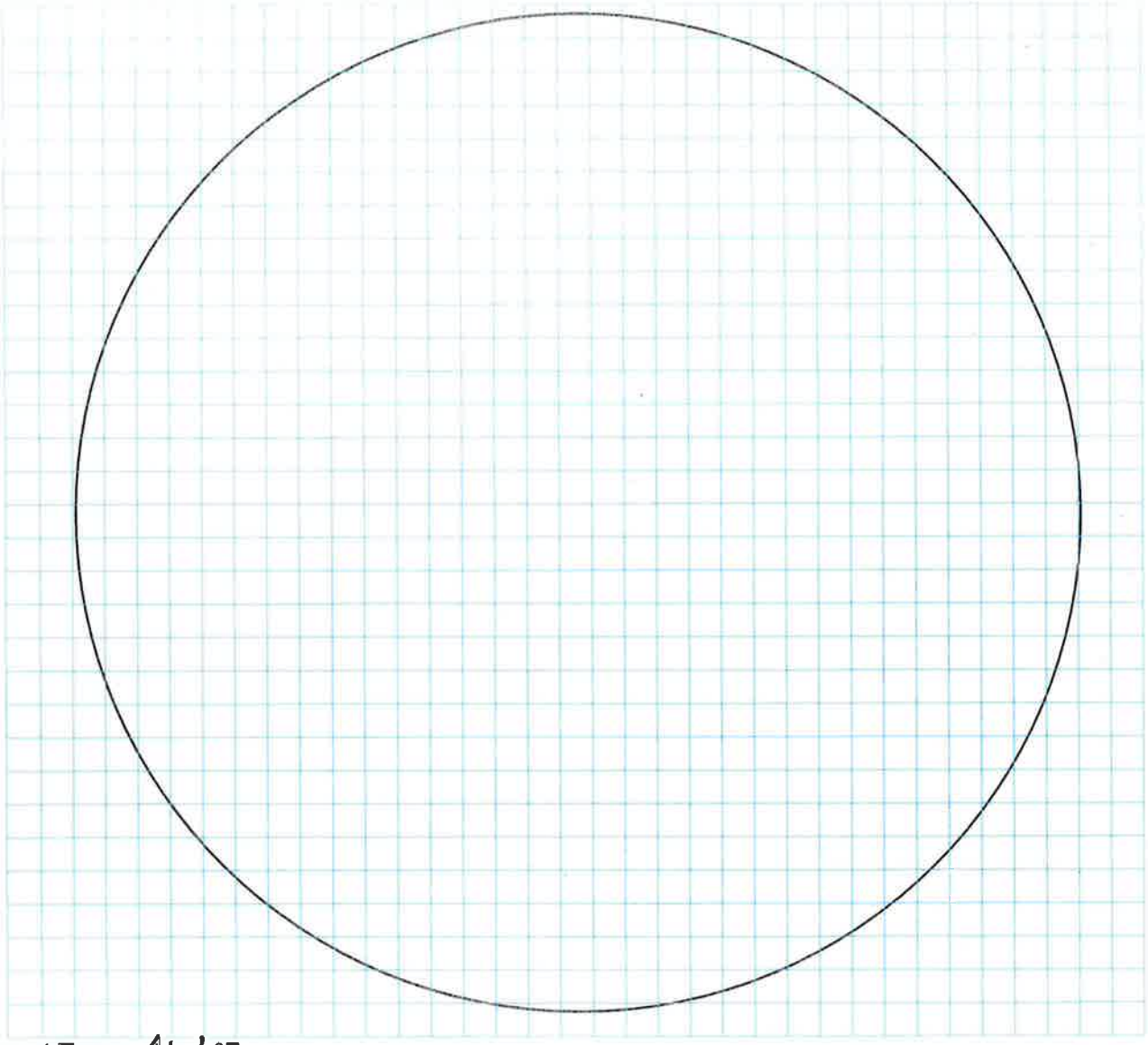
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/9/12

Observation Form

Temperature: 45 °F
Beaker #: 2
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☐ After 1 Stir
- ☒ After 3 stirs



Sediment Temp: 46.1 °F

Surface Water Temp: 45.5 °F

Visible Light Sheen:
- ☒ None
- ☐ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☒ None
- ☐ Fluoresced Oil
- ☐ Fluoresced globules

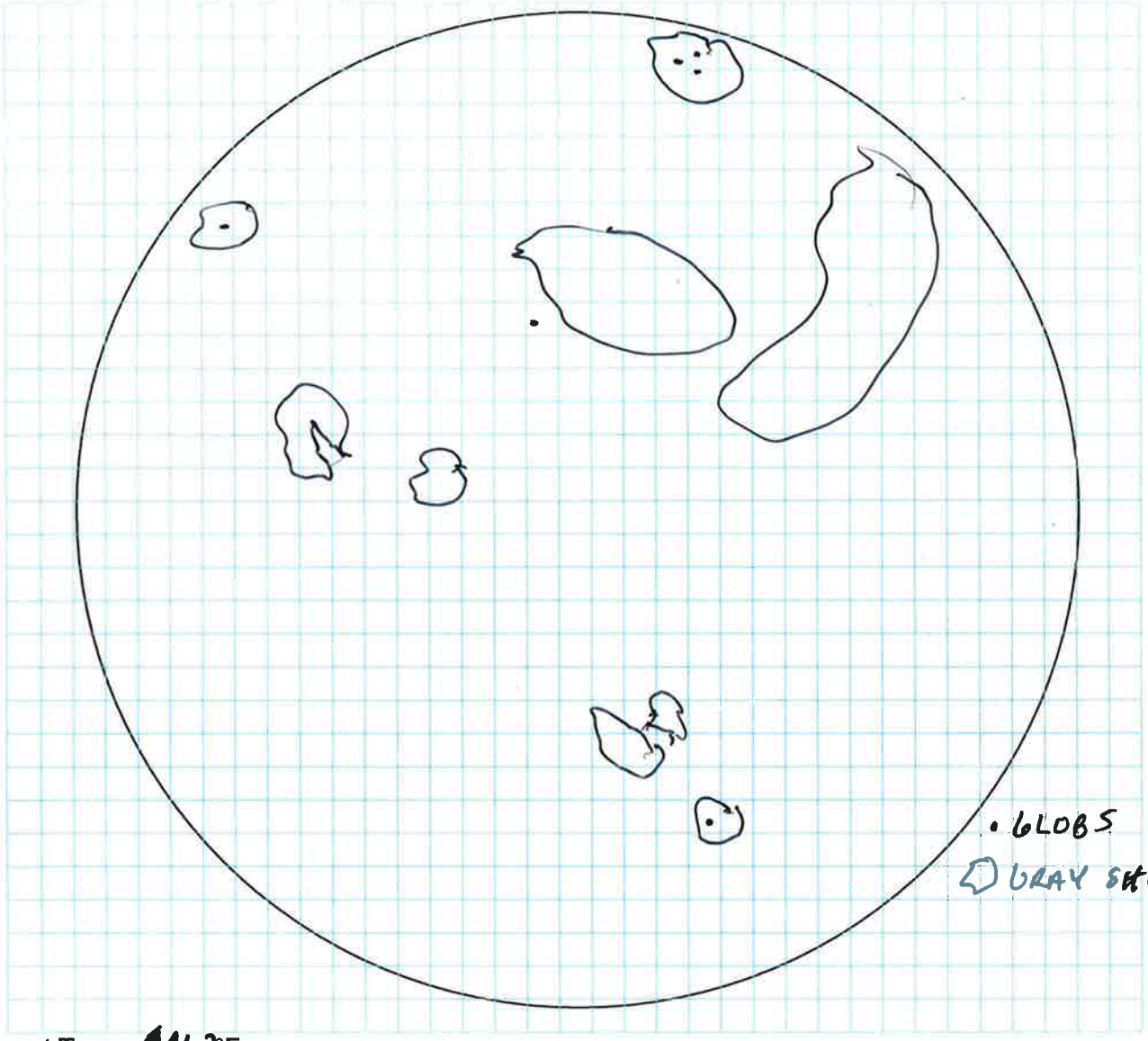
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/9/12

Observation Form

Temperature: 45 °F
Beaker #: 3
Mile Post: 10.75

Observation:
- ☒ Prior to agitation
- ☐ After 1 Stir
- ☐ After 3 stirs



Sediment Temp: ~~46.2~~ °F
Surface Water Temp: 46.0 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☐ Fluoresced Oil
- ☒ Fluoresced globules 3 PINHEAD SIZED GLOBS

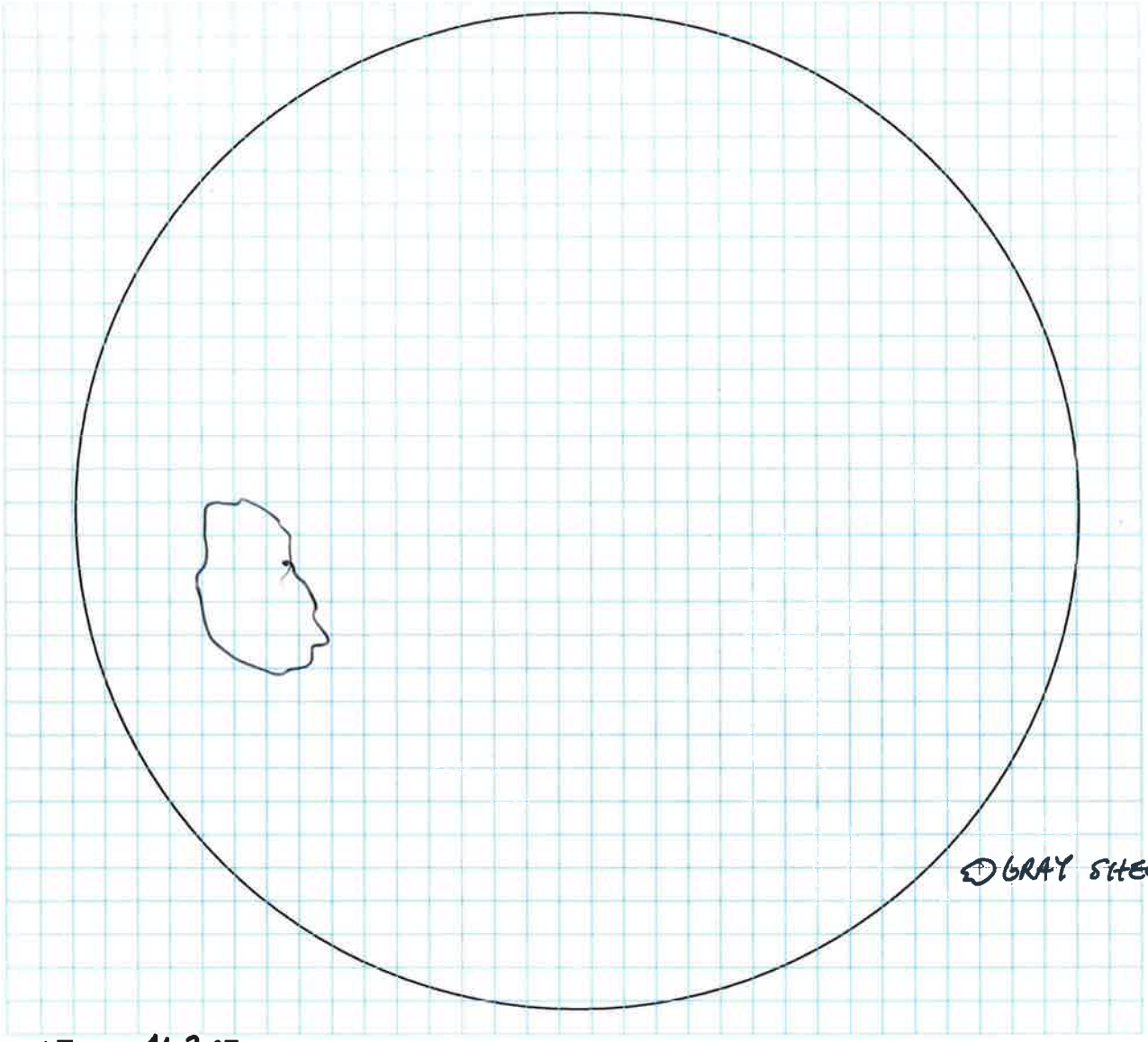
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: [signature] Date: 1/9/12

Observation Form

Temperature: 45 °F
Beaker #: 3
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☒ After 1 Stir
- ☐ After 3 stirs



Sediment Temp: 46.2 °F

Surface Water Temp: 46.0 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☒ None
- ☐ Fluoresced Oil
- ☐ Fluoresced globules

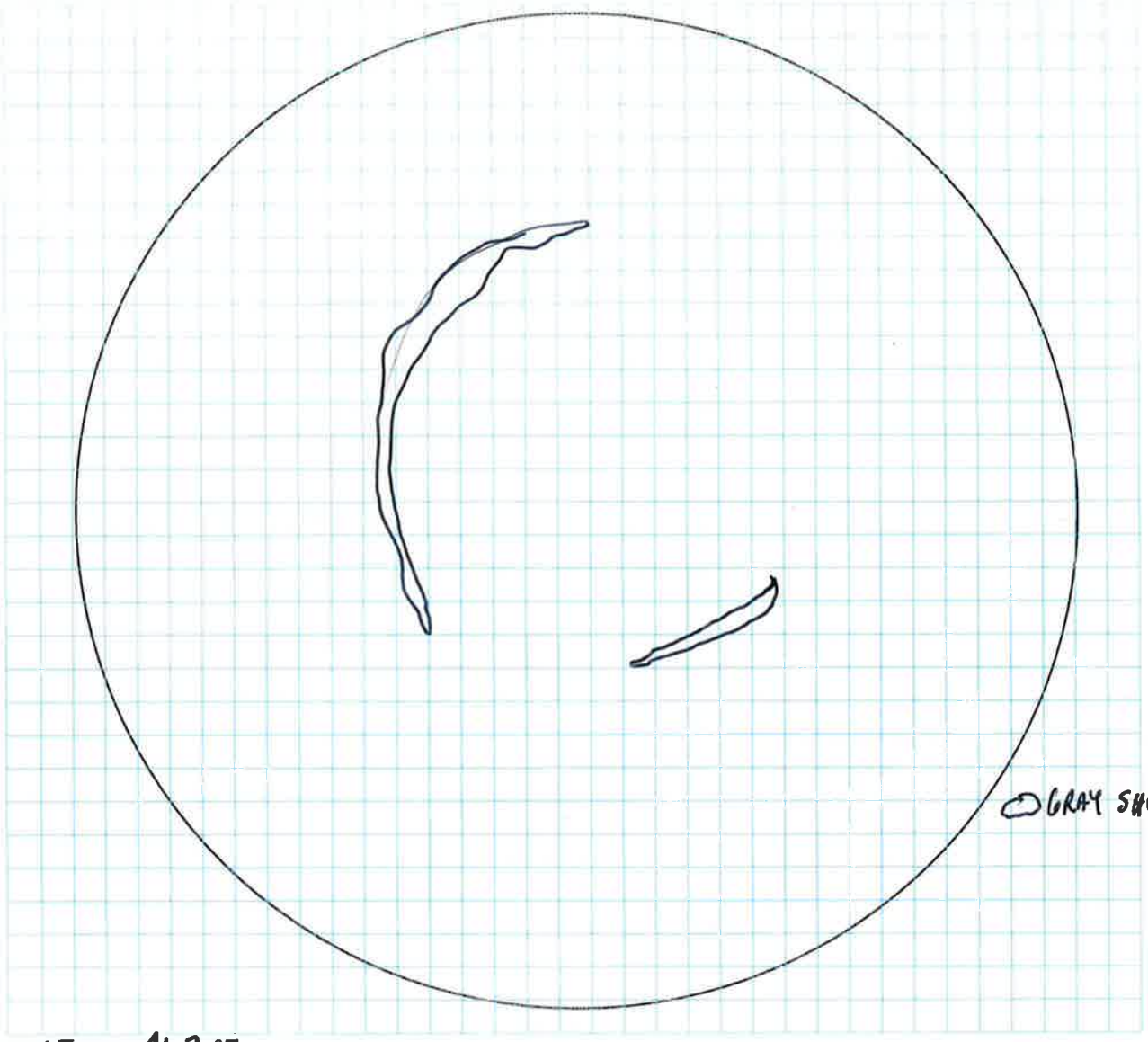
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/9/12

Observation Form

Temperature: 45 °F
Beaker #: 3
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☐ After 1 Stir
- ☒ After 3 stirs



Sediment Temp: 46.2 °F

Surface Water Temp: 46.0 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☒ None
- ☐ Fluoresced Oil
- ☐ Fluoresced globules

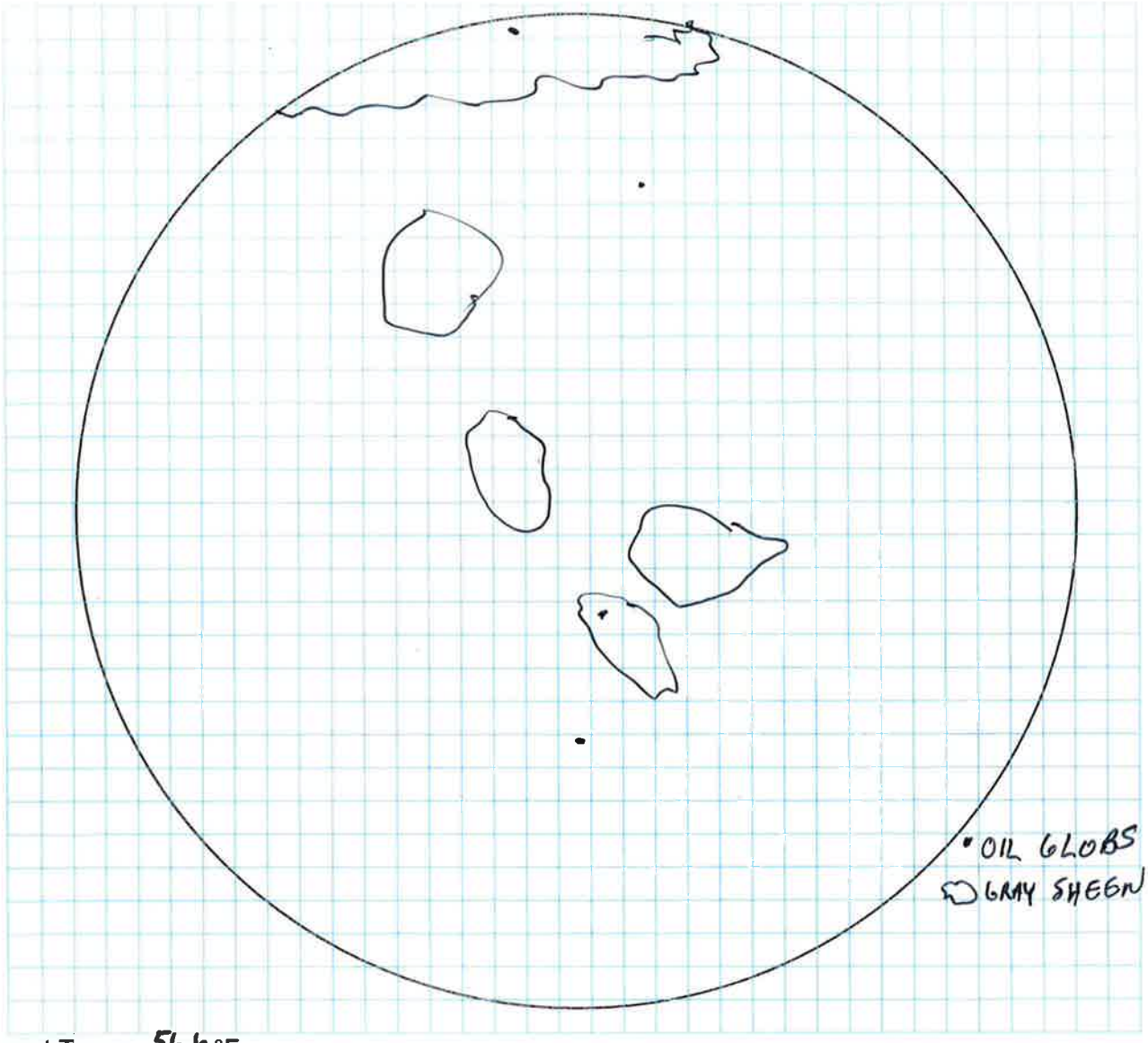
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/9/12

Observation Form

Temperature: 55 °F
Beaker #: 1
Mile Post: 10.75

Observation:
- ☒ Prior to agitation
- ☐ After 1 Stir
- ☐ After 3 stirs



Sediment Temp: 56.6 °F

Surface Water Temp: 55.2 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☐ Fluoresced Oil
- ☒ Fluoresced globules 2 PINHEAD SIZED GLOBS

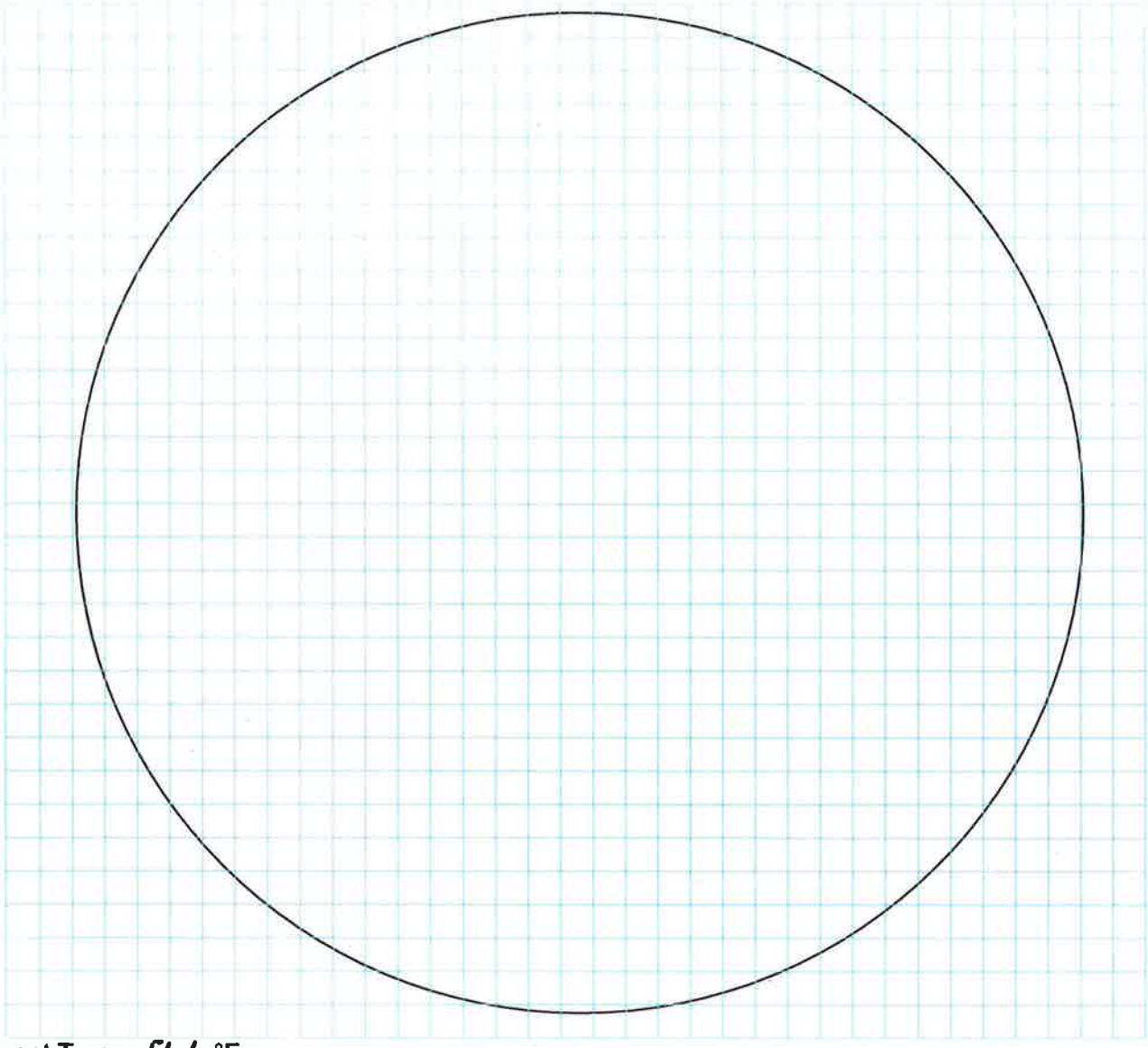
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/9/12

Observation Form

Temperature: 55 °F
Beaker #: 1
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☒ After 1 Stir
- ☐ After 3 stirs



Sediment Temp: 56.6 °F

Surface Water Temp: 55.2 °F

Visible Light Sheen:
- ☒ None
- ☐ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☐ Fluoresced Oil
- ☒ Fluoresced globules 2 PIN HEAD SIZED GLOBULES

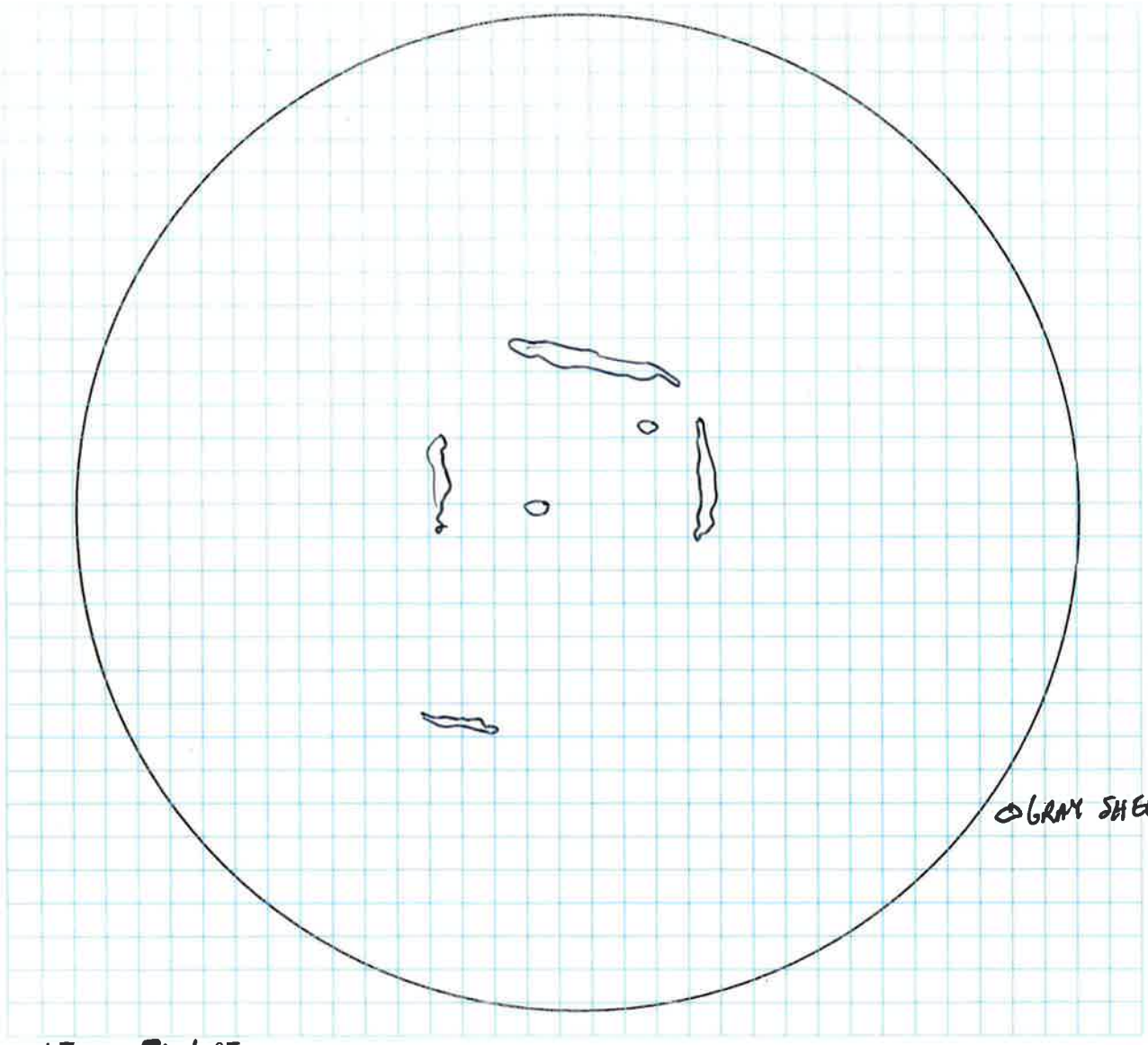
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: [signature] Date: 1/9/12

Observation Form

Temperature: 55 °F
Beaker #: 21
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☐ After 1 Stir
- ☒ After 3 stirs



Sediment Temp: 56.6 °F

Surface Water Temp: 55.2 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Globules:
Count # _____
Ave. Dia.: _____ in.

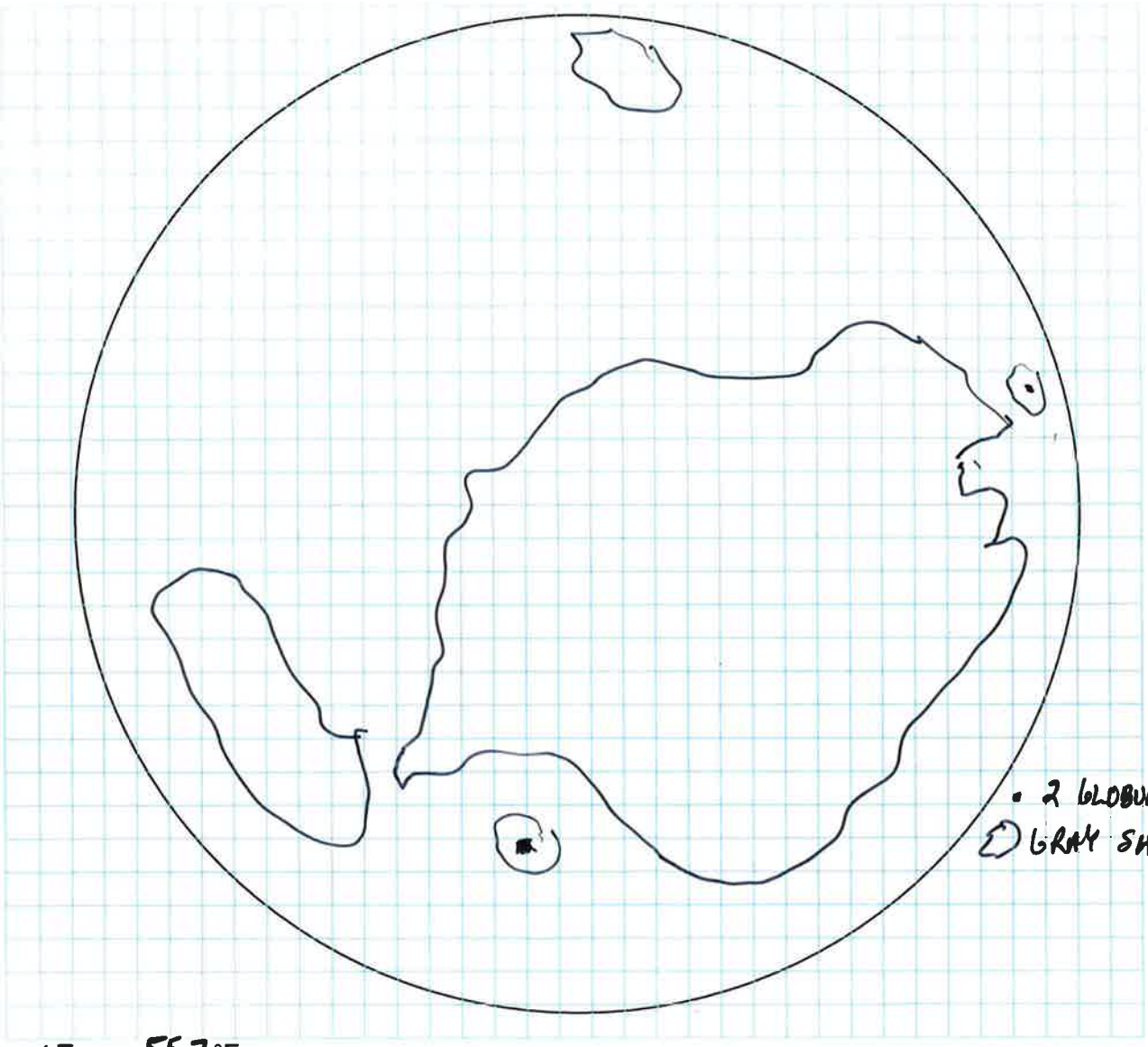
UV Light Sheen:
- ☐ None
- ☐ Fluoresced Oil
- ☒ Fluoresced globules 2 PIN HEAD SIZE GLOBS ADHERED TO SIDE OF BEAKER @ H2O LEVEL

Sign Off: _____ Date: 1/9/12

Observation Form

Temperature: 55 °F
Beaker #: 2
Mile Post: 10.75

Observation:
- ☒ Prior to agitation
- ☐ After 1 Stir
- ☐ After 3 stirs



Sediment Temp: 55.7 °F

Surface Water Temp: 56.4 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☐ Fluoresced Oil
- ☒ Fluoresced globules 4 GLOBULES - PIN HEAD SIZE

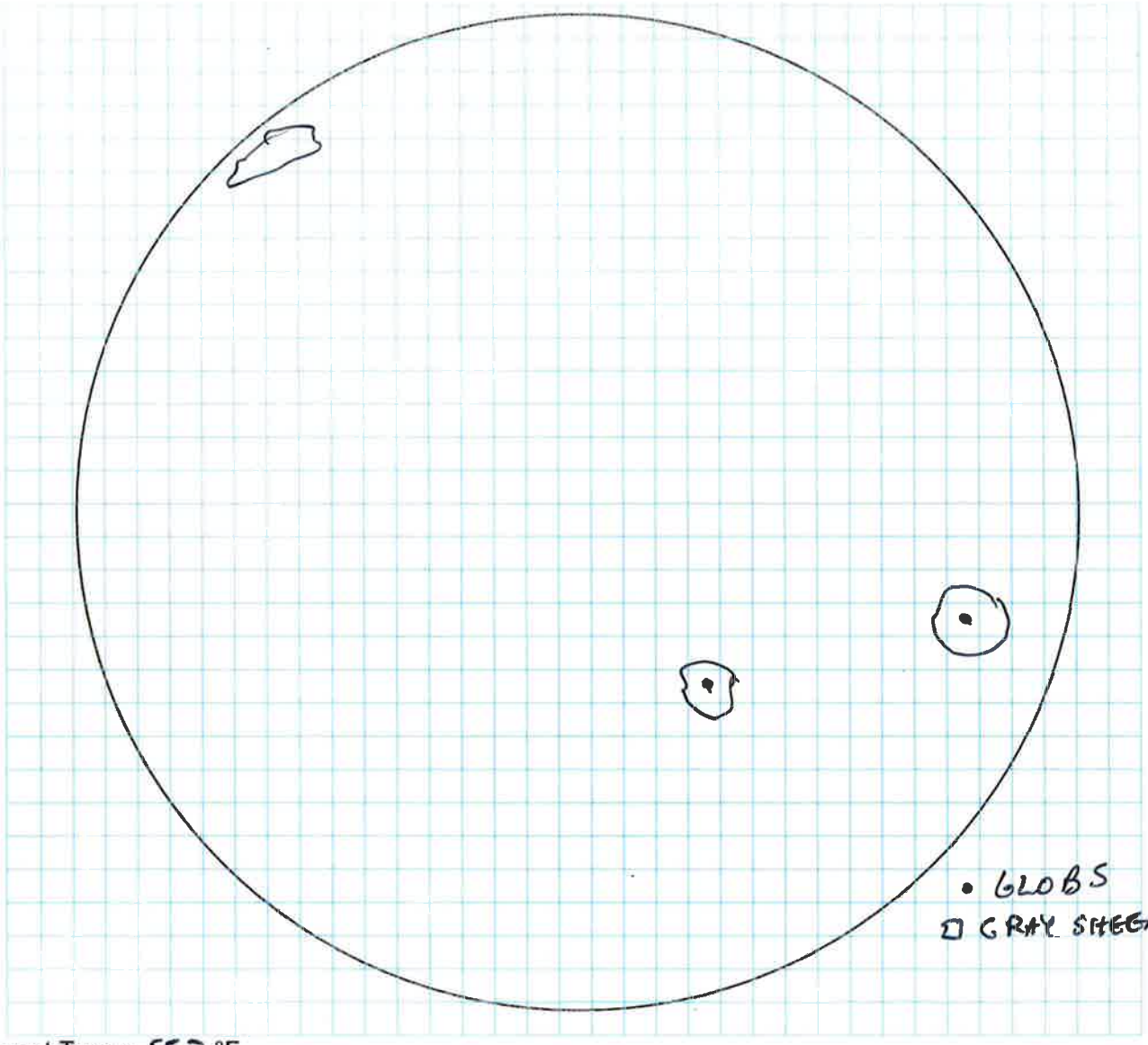
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: [signature] Date: 1/9/12

Observation Form

Temperature: 55 °F
Beaker #: 2
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☒ After 1 Stir
- ☐ After 3 stirs



Sediment Temp: 55.7 °F

Surface Water Temp: 56.9 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☐ Fluoresced Oil
- ☒ Fluoresced globules 1 1/16" SIZED GLOBULE

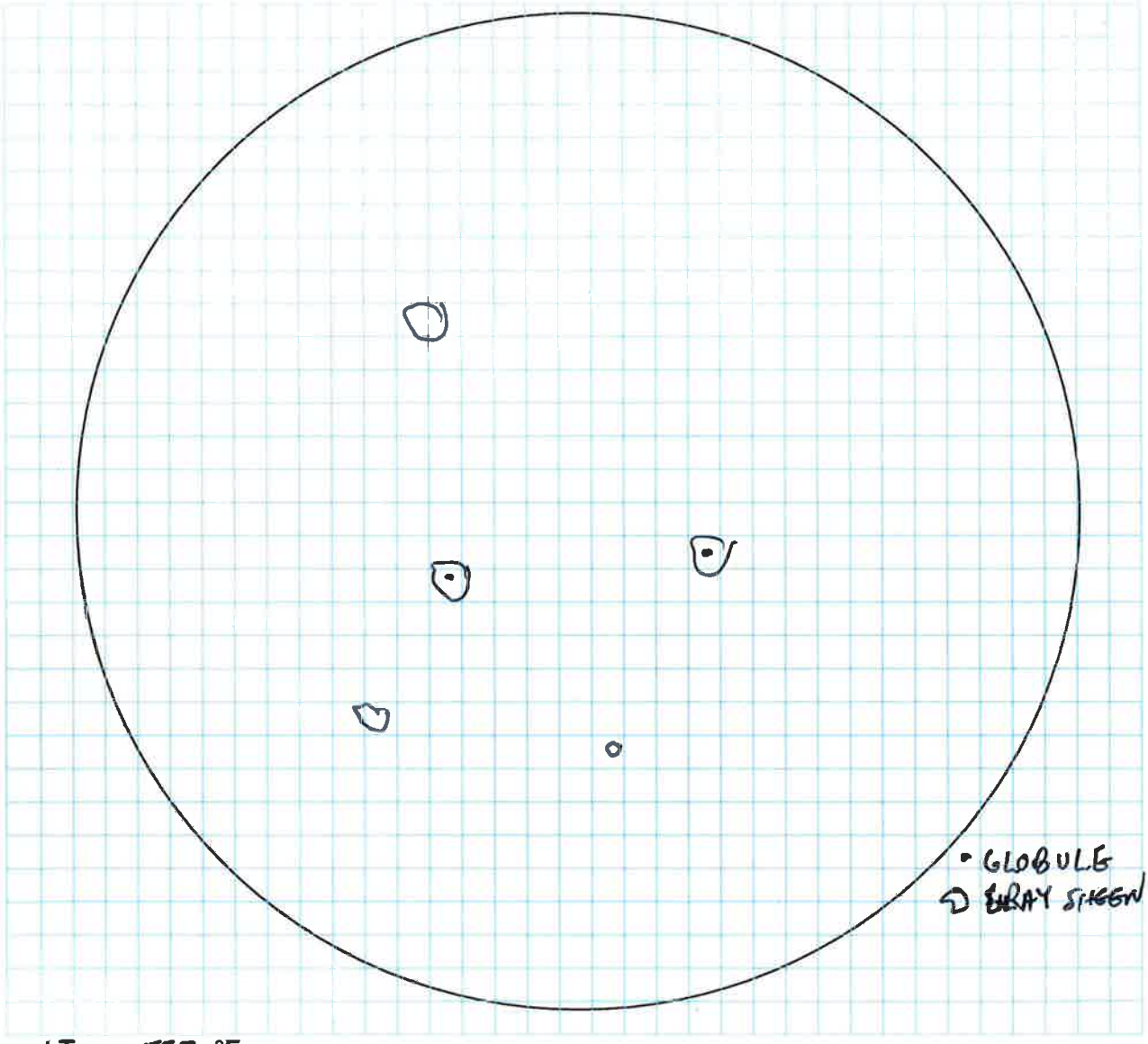
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: [signature] Date: 1/9/12

Observation Form

Temperature: 55 °F
Beaker #: 2
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☐ After 1 Stir
- ☒ After 3 stirs



Sediment Temp: 55.7 °F

Surface Water Temp: 56.1 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☐ Fluoresced Oil
- ☒ Fluoresced globules 2 ~ 1/16" SIZED GLOBULES

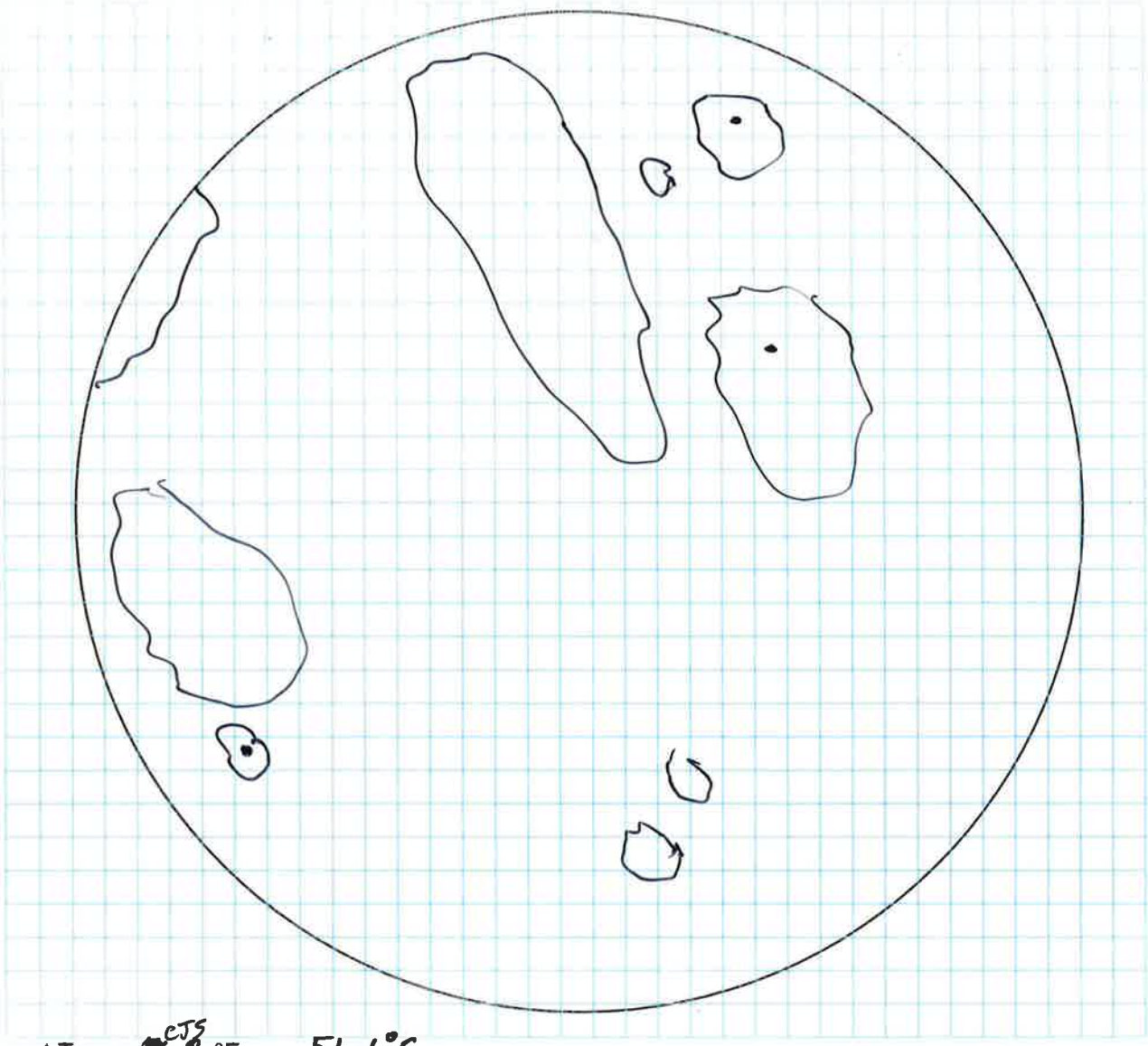
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/9/12

Observation Form

Temperature: 55 °F
Beaker #: 3
Mile Post: 10.75

Observation:
- [x] Prior to agitation
- [ ] After 1 Stir
- [ ] After 3 stirs



Sediment Temp: CJS [redacted] °F 56.1°F

Surface Water Temp: CJS [redacted] °F 56.3°F

Visible Light Sheen:
- [ ] None
- [x] Gray
- [ ] Silver
- [ ] Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- [ ] None
- [x] Fluoresced Oil 4 AREAS OF L DIME SIZE
- [x] Fluoresced globules 1 PINHEAD SIZE

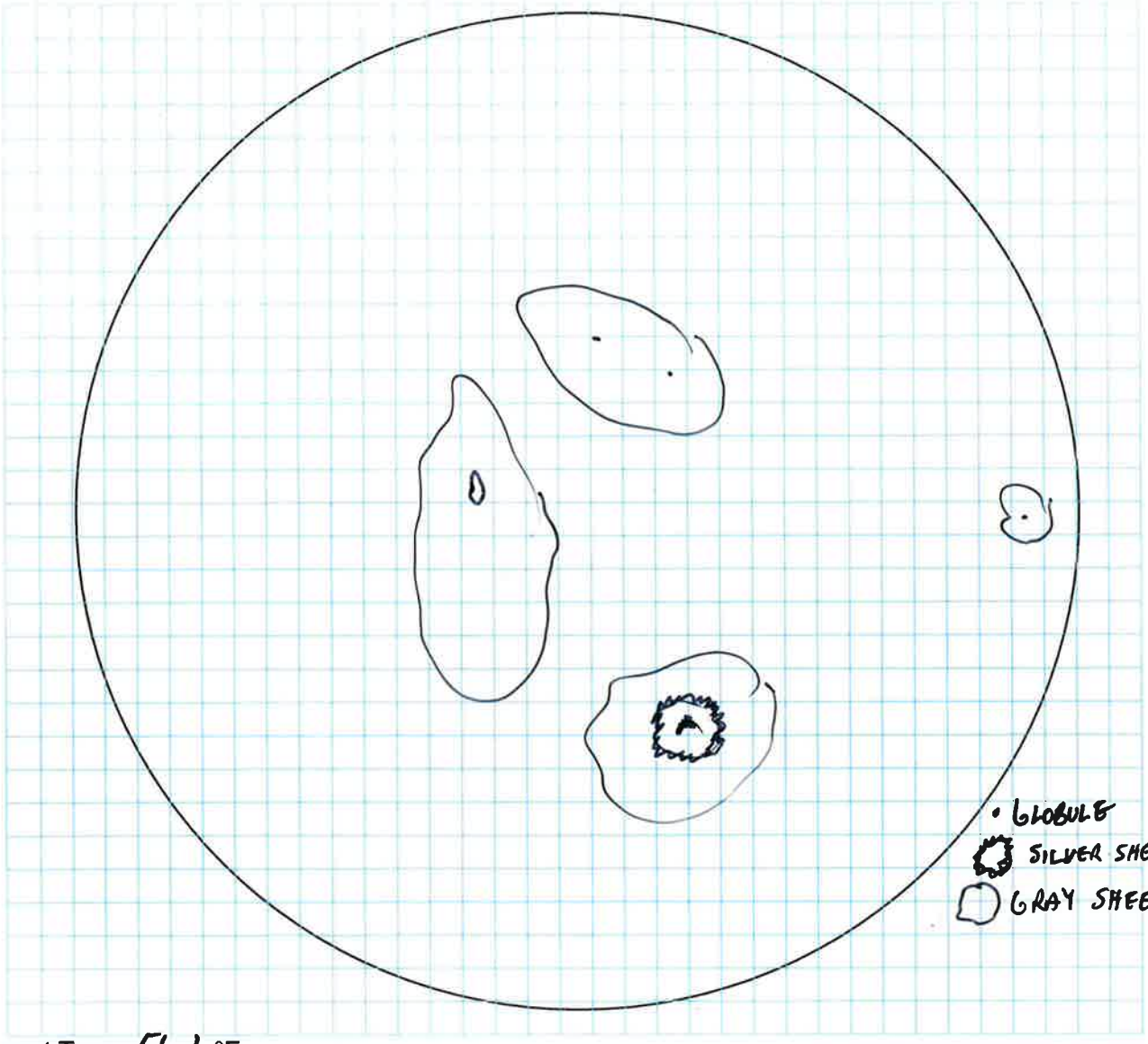
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: [signature] Date: 1/9/12

Observation Form

Temperature: 55 °F
Beaker #: 3
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☒ After 1 Stir
- ☐ After 3 stirs



Sediment Temp: 56.1 °F

Surface Water Temp: 56.3 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☒ Silver
- ☐ Metallic / transitional

Percent Sheen:
- n (# whole squares) = _____
- m (# partial squares) = _____
- SA (Surface Area) = _____ in^2
- SA= (n x 0.036) + (m x 0.018)
- % = SA/ 26.4= _____%
- = (n + m) / 727 x 100 = _____%

Globules:
- Count # _____
- Ave. Dia.: _____ in.

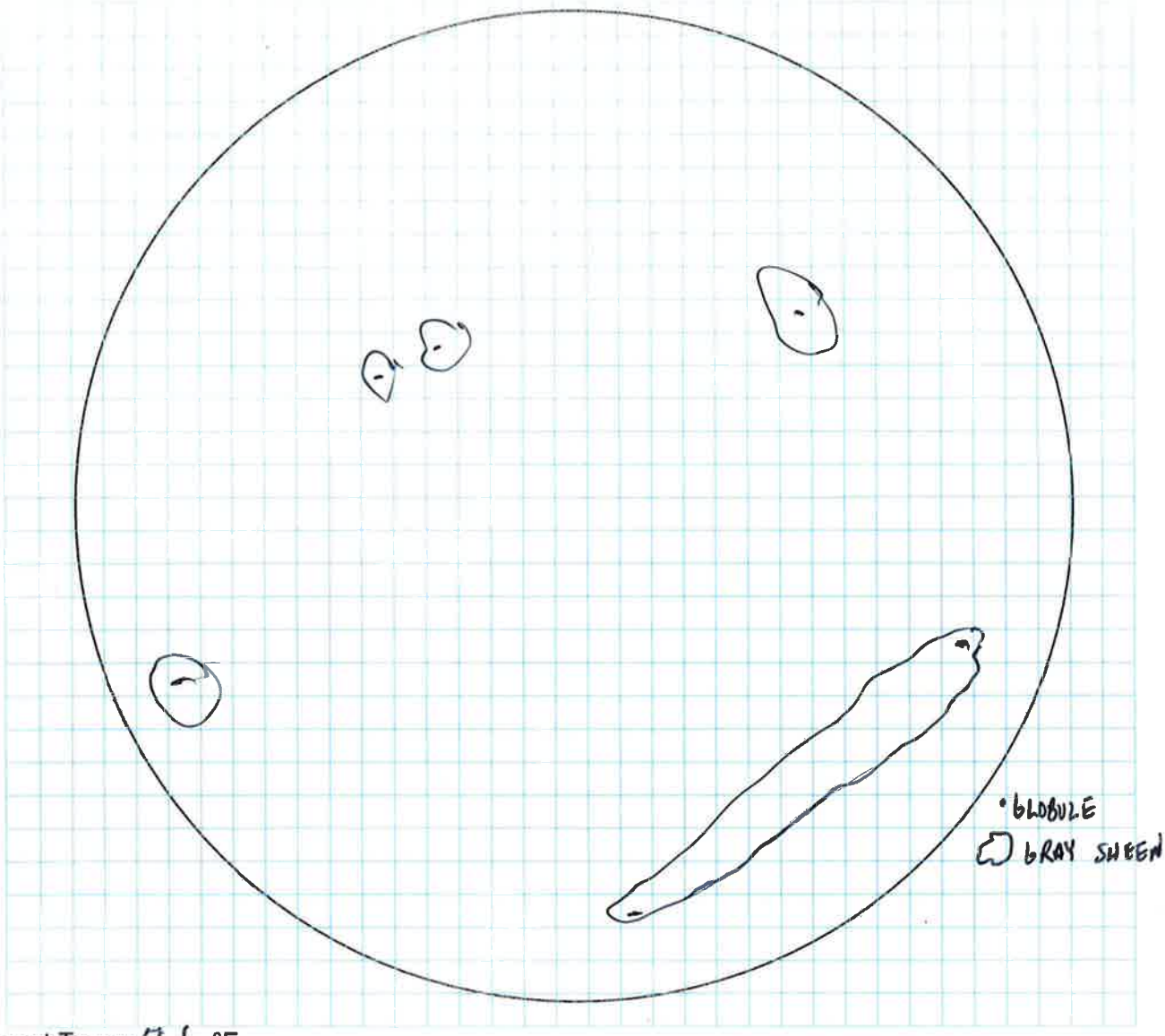
UV Light Sheen:
- ☐ None
- ☐ Fluoresced Oil
- ☒ Fluoresced globules 5 PIN HEAD TO 1/16" SIZED GLOBULES

Sign Off: [signature] Date: 1/9/12

Observation Form

Temperature: 55 °F
Beaker #: 3
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☐ After 1 Stir
- ☒ After 3 stirs



Sediment Temp: 56.1 °F

Surface Water Temp: 56.3 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☒ Fluoresced Oil | LESS THAN DIME SIZED
- ☒ Fluoresced globules | 4 PIN HEAD SIZED GLOBULES

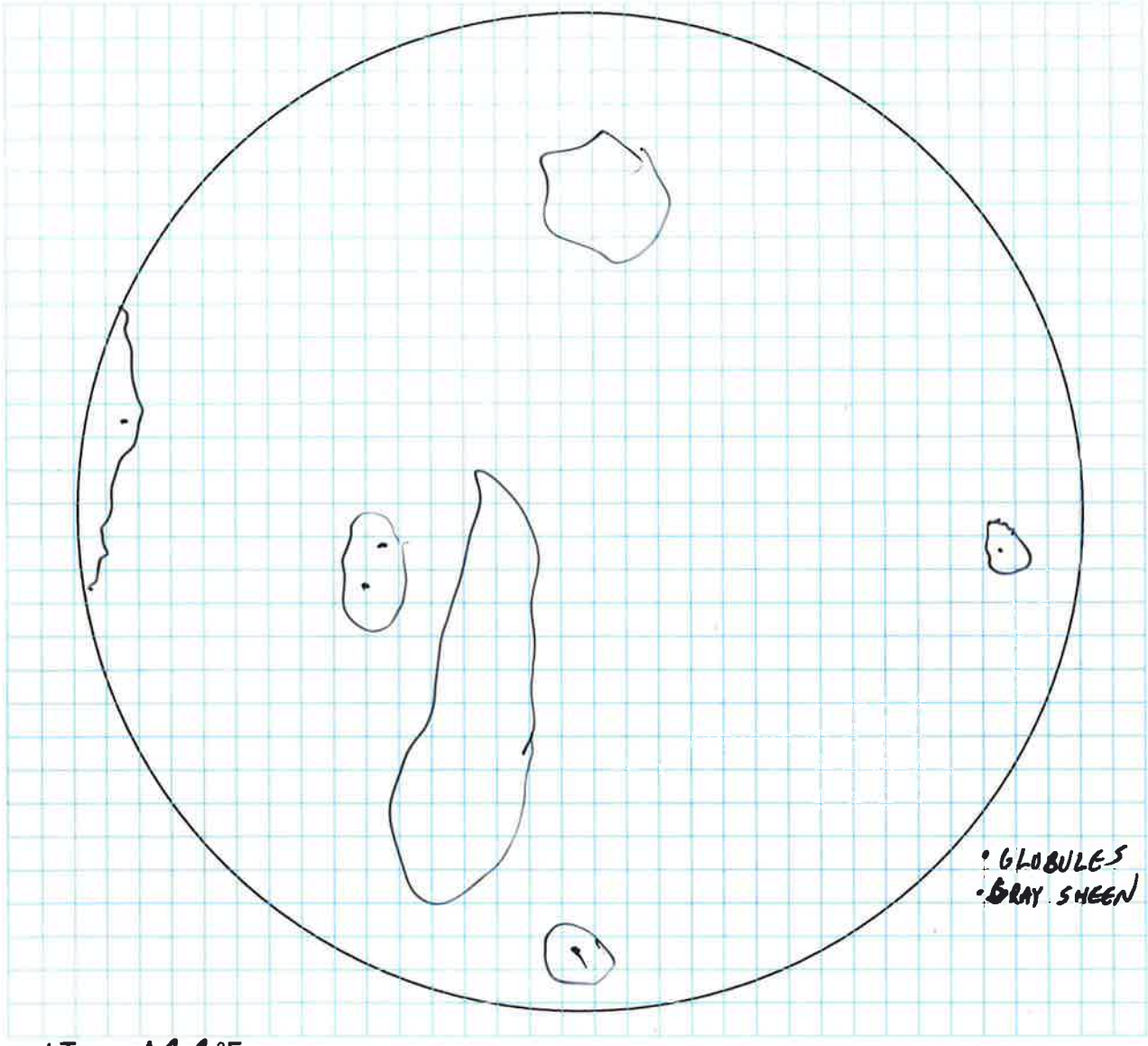
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/9/12

Observation Form

Temperature: 65 °F
Beaker #: 1
Mile Post: 10.75

Observation:
- ☒ Prior to agitation
- ☐ After 1 Stir
- ☐ After 3 stirs



Sediment Temp: 69.4 °F

Surface Water Temp: 65.0 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☒ Fluoresced Oil VERY STRINGY (ELONGATED) IN SHAPE
- ☒ Fluoresced globules 1 1/16" SIZED GLOBULE

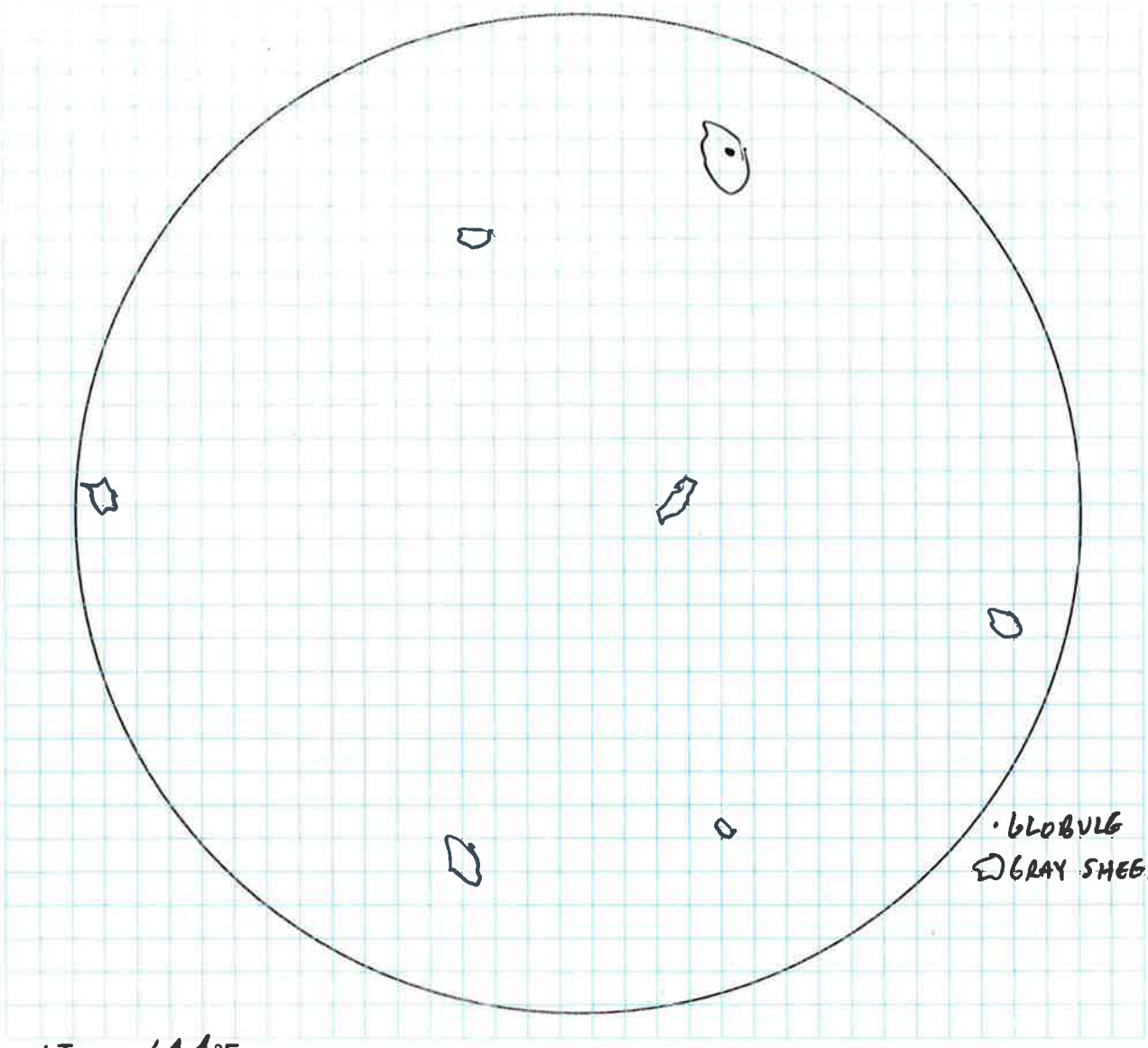
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/9/12

Observation Form

Temperature: 65 °F
Beaker #: 1
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☒ After 1 Stir
- ☐ After 3 stirs



Sediment Temp: 64.4 °F

Surface Water Temp: 65.0 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☐ Fluoresced Oil
- ☒ Fluoresced globules 4 PINHEAD SIZED

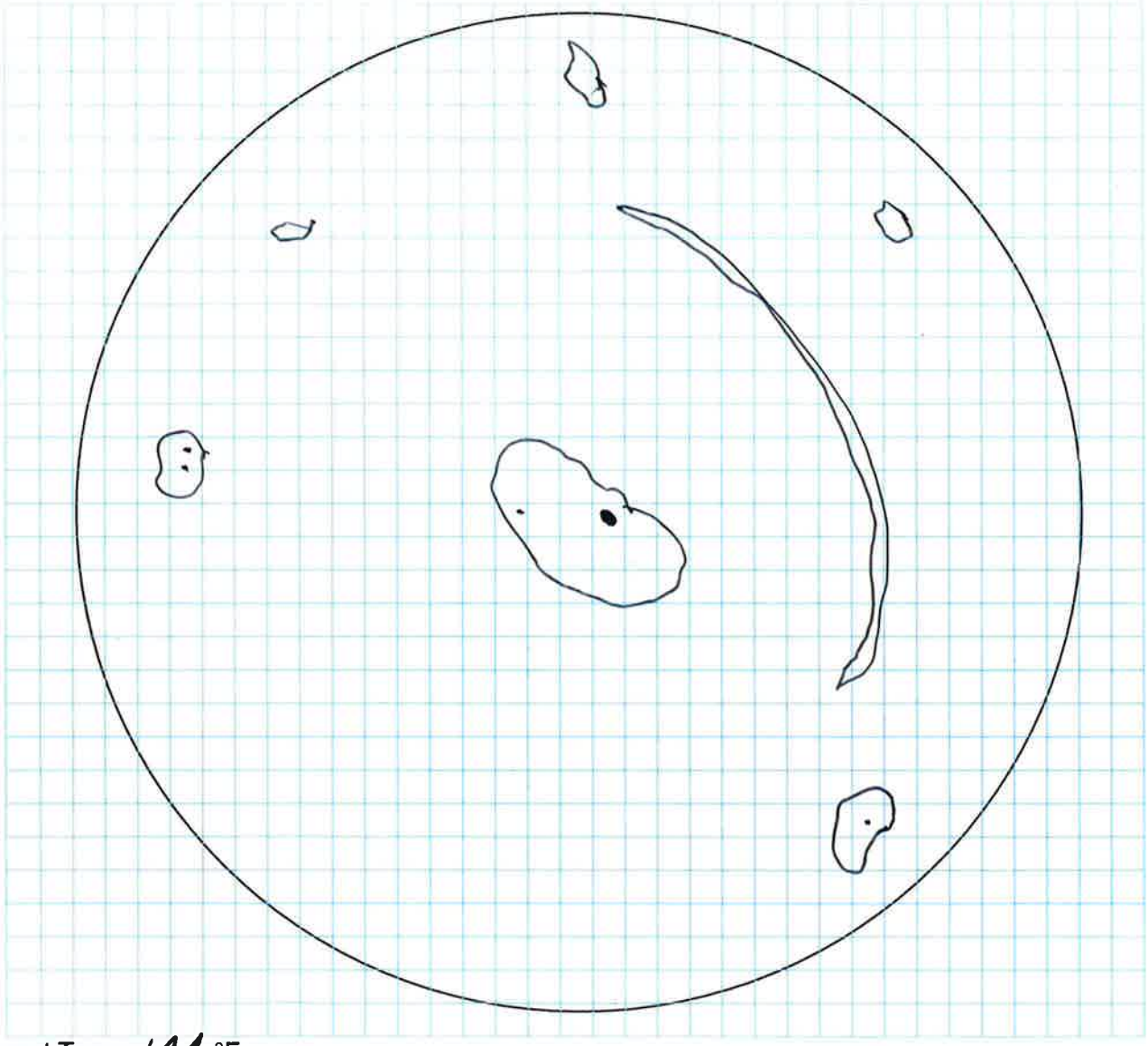
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/9/12

Observation Form

Temperature: 65 °F
Beaker #: 1
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☒ After 1 Stir (CS)
- ☒ After 3 stirs



Sediment Temp: 64.1 °F

Surface Water Temp: 65.0 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☒ Fluoresced Oil LARGE AREA OF FLUORESCED OIL IN CENTER (CONTINUOS STREAMER COVERING 40% OF SHEARS)
- ☒ Fluoresced globules 4 PINHEAD SIZED GLOBULES

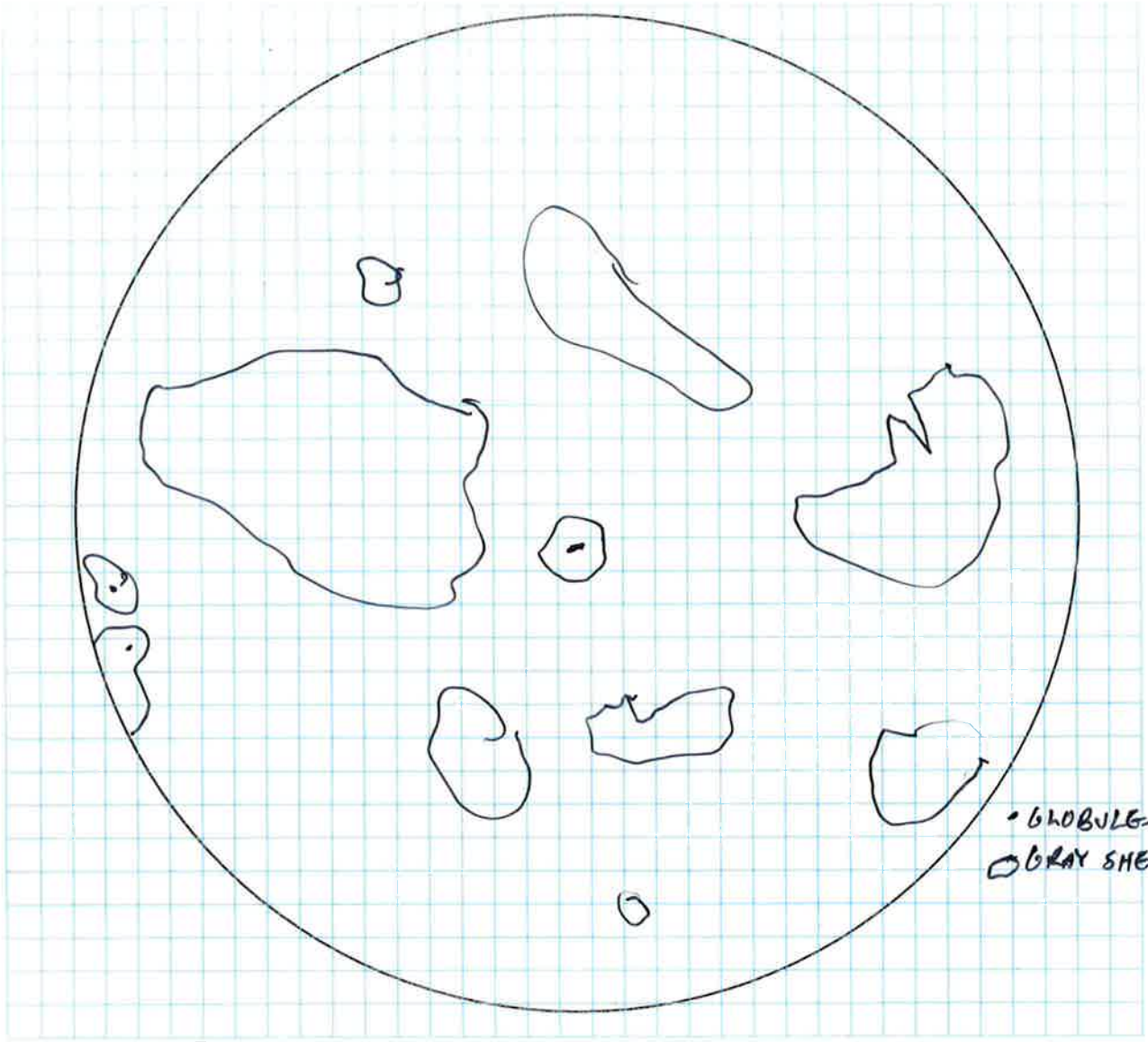
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: [signature] Date: 1/9/12

Observation Form

Temperature: 65 °F
Beaker #: 7
Mile Post: 10.75

Observation:
- ☒ Prior to agitation
- ☐ After 1 Stir
- ☐ After 3 stirs



Sediment Temp: 66.5 °F

Surface Water Temp: 66.9 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☒ Fluoresced Oil SEVERAL AREAS COVERING ~ 30% OF SURFACE AREA
- ☒ Fluoresced globules 2 PINHEAD SIZED

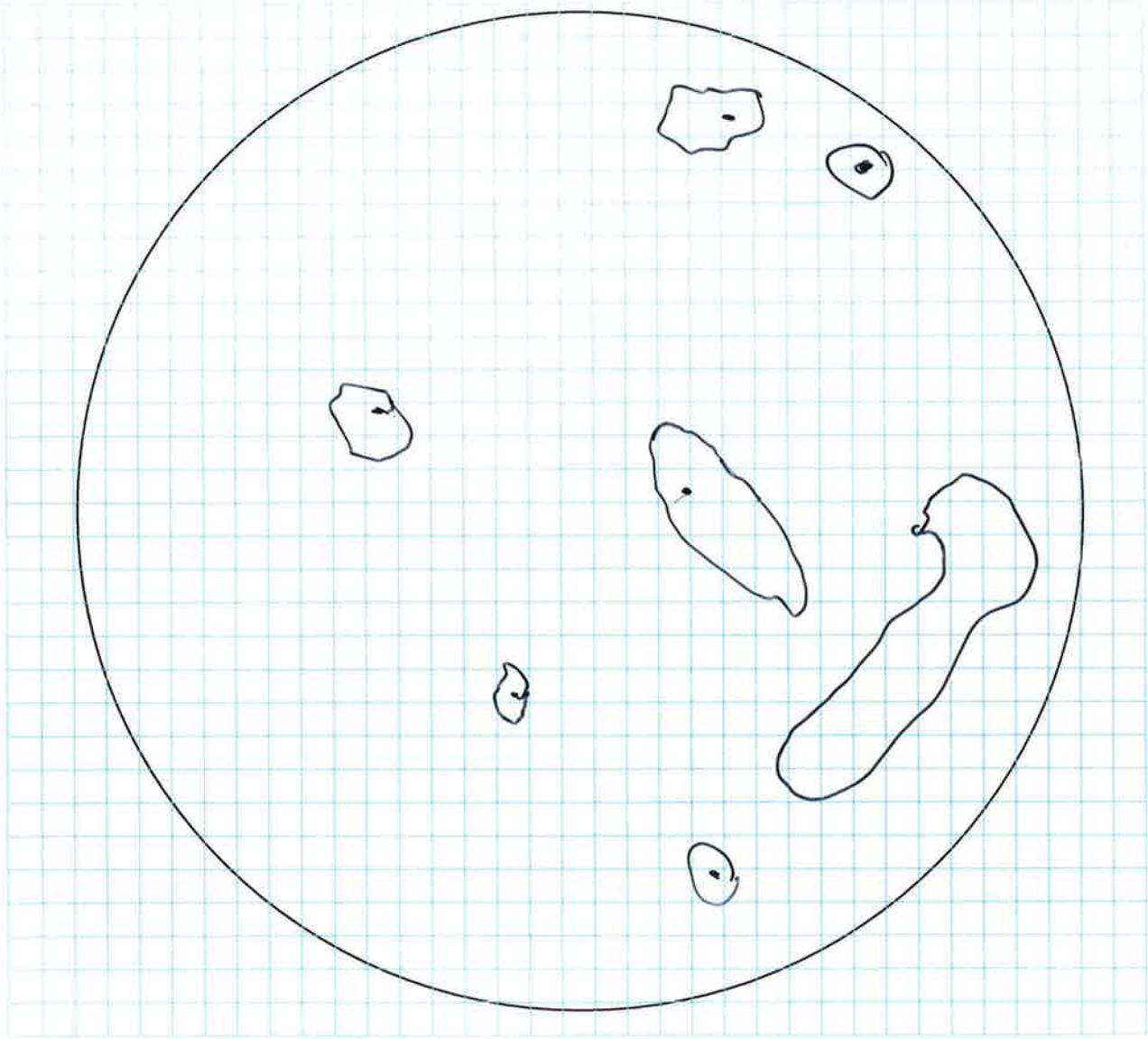
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: [signature] Date: 1/9/12

Observation Form

Temperature: 65 °F
Beaker #: 2
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☒ After 1 Stir
- ☐ After 3 stirs



Sediment Temp: 66.5 °F

Surface Water Temp: 66.9 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☒ Fluoresced Oil
- ☒ Fluoresced globules 2 1/16" SIZED GLOBULES

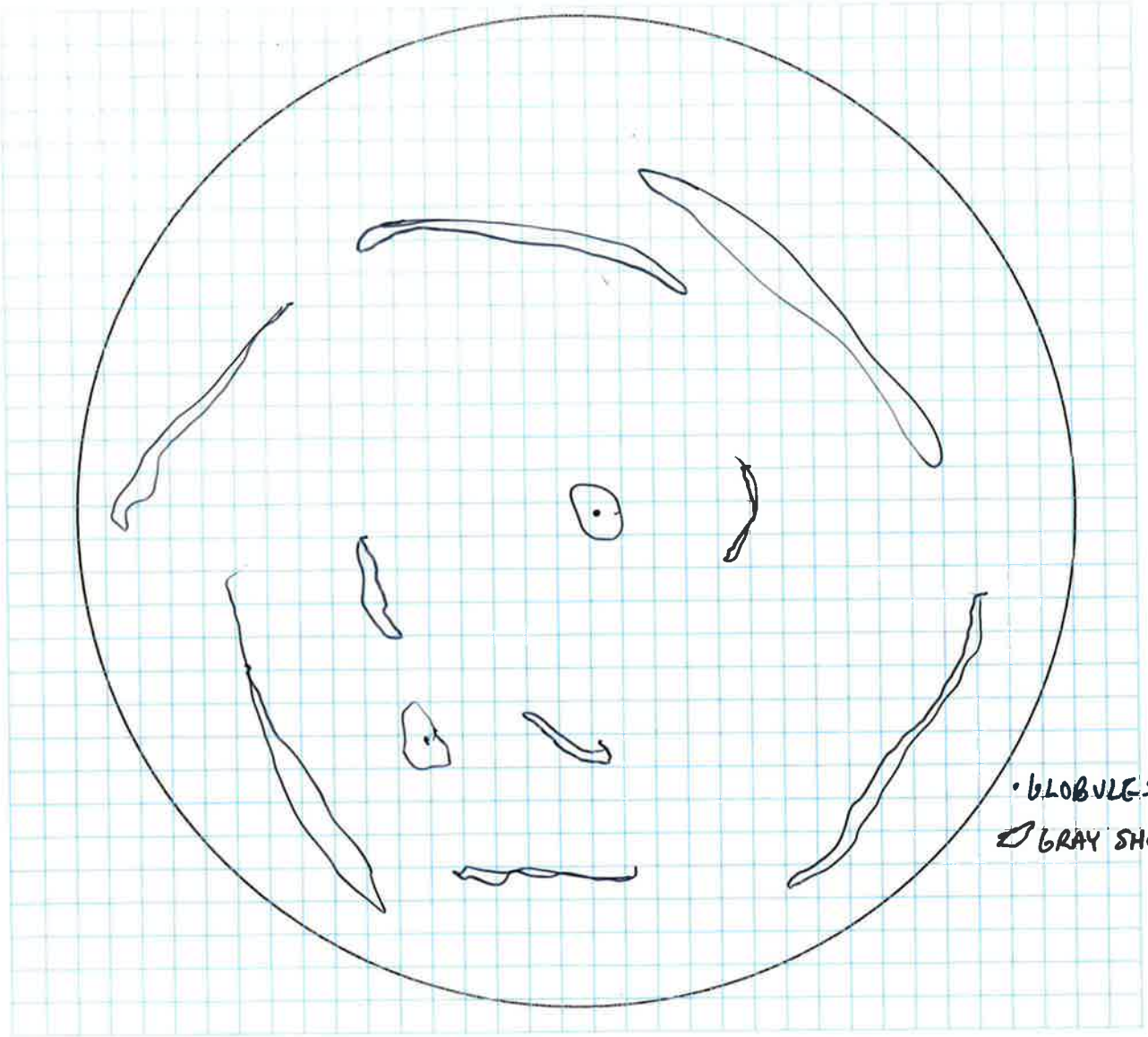
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/9/12

Observation Form

Temperature: 65 °F
Beaker #: 2
Mile Post: 16.75

Observation:
- ☐ Prior to agitation
- ☐ After 1 Stir
- ☒ After 3 stirs



Sediment Temp: 66.5 °F

Surface Water Temp: 66.9 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☒ Fluoresced Oil FEW SMALL AREAS COVERING LESS THAN 10% OF SURFACE AREA
- ☒ Fluoresced globules 2 PINHEAD SIZED GLOBULES

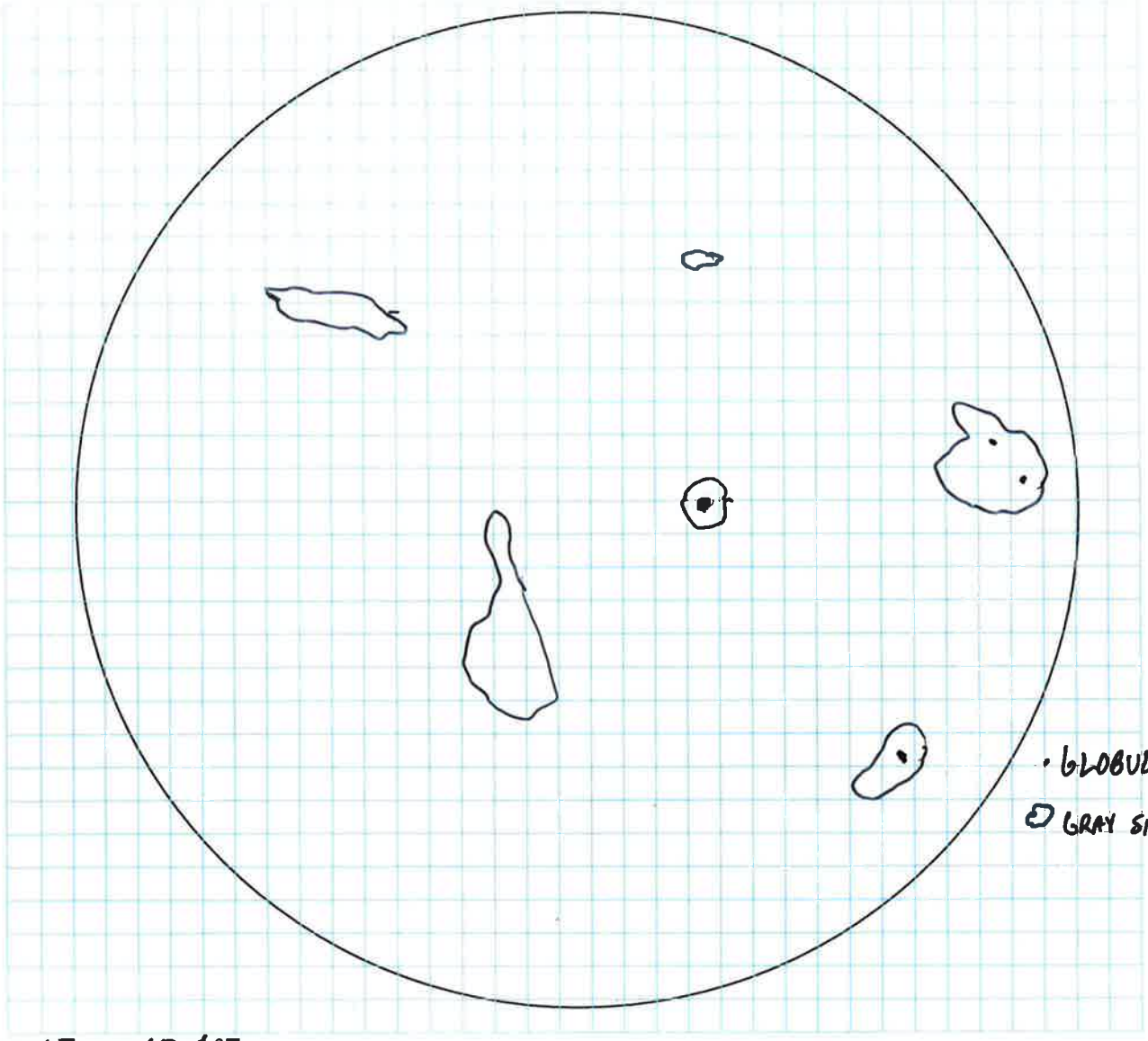
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: G. J. Lui Date: 1/9/12

Observation Form

Temperature: 65 °F
Beaker #: 3
Mile Post: 10.75

Observation:
- [x] Prior to agitation
- [ ] After 1 Stir
- [ ] After 3 stirs



Sediment Temp: 67.0 °F

Surface Water Temp: 66.8 °F

Visible Light Sheen:
- [ ] None
- [x] Gray
- [ ] Silver
- [ ] Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- [ ] None
- [ ] Fluoresced Oil
- [x] Fluoresced globules 2 ~ 1/16" SIZED GLOBULES

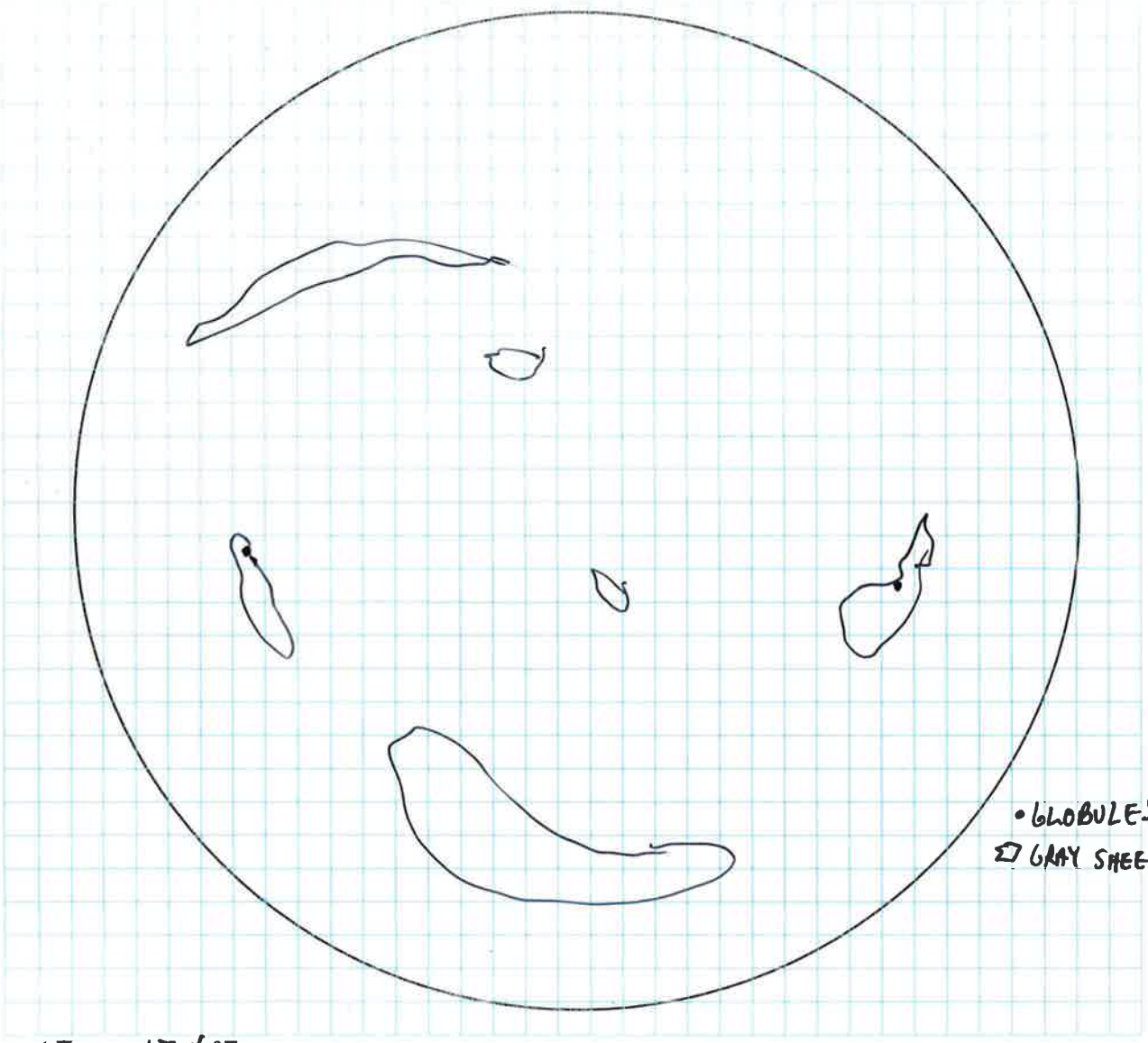
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: [signature] Date: 1/9/12

Observation Form

Temperature: 65 °F
Beaker #: 3
Mile Post: 16.75

Observation:
- ☐ Prior to agitation
- ☒ After 1 Stir
- ☐ After 3 stirs



Sediment Temp: 67.0 °F

Surface Water Temp: 66.8 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☒ None
- ☐ Fluoresced Oil
- ☐ Fluoresced globules

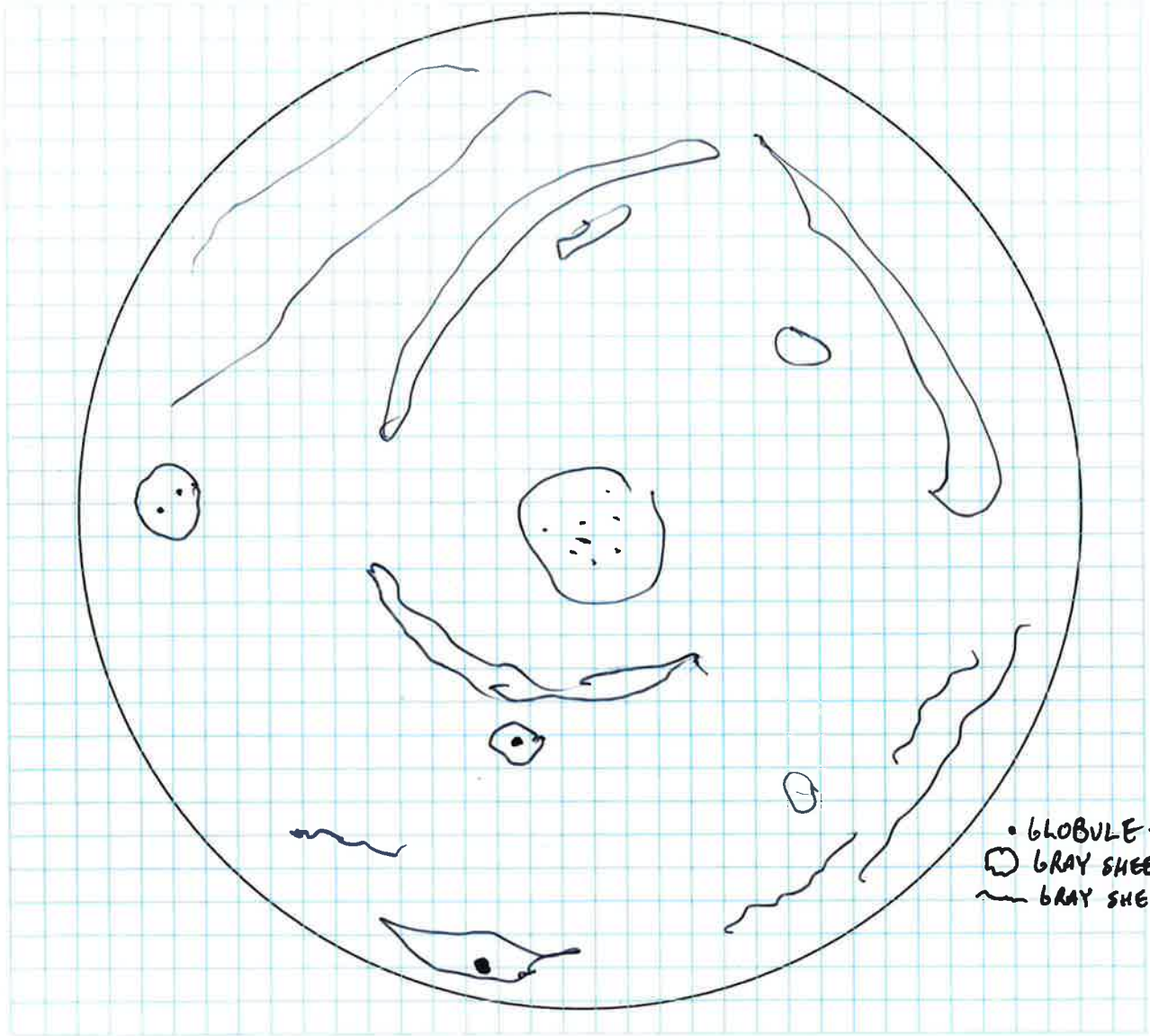
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: [signature] Date: 1/9/12

Observation Form

Temperature: 65 °F
Beaker #: 3
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☐ After 1 Stir
- ☒ After 3 stirs



Sediment Temp: 67.0 °F

Surface Water Temp: 66.8 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☒ Fluoresced Oil SEVERAL AREAS, INCLUDING STREAMERS COVERING 50-60% OF SURFACE AREA
- ☒ Fluoresced globules 6 GLOBULES FROM PIN HEAD TO 1/8" DIAMETER

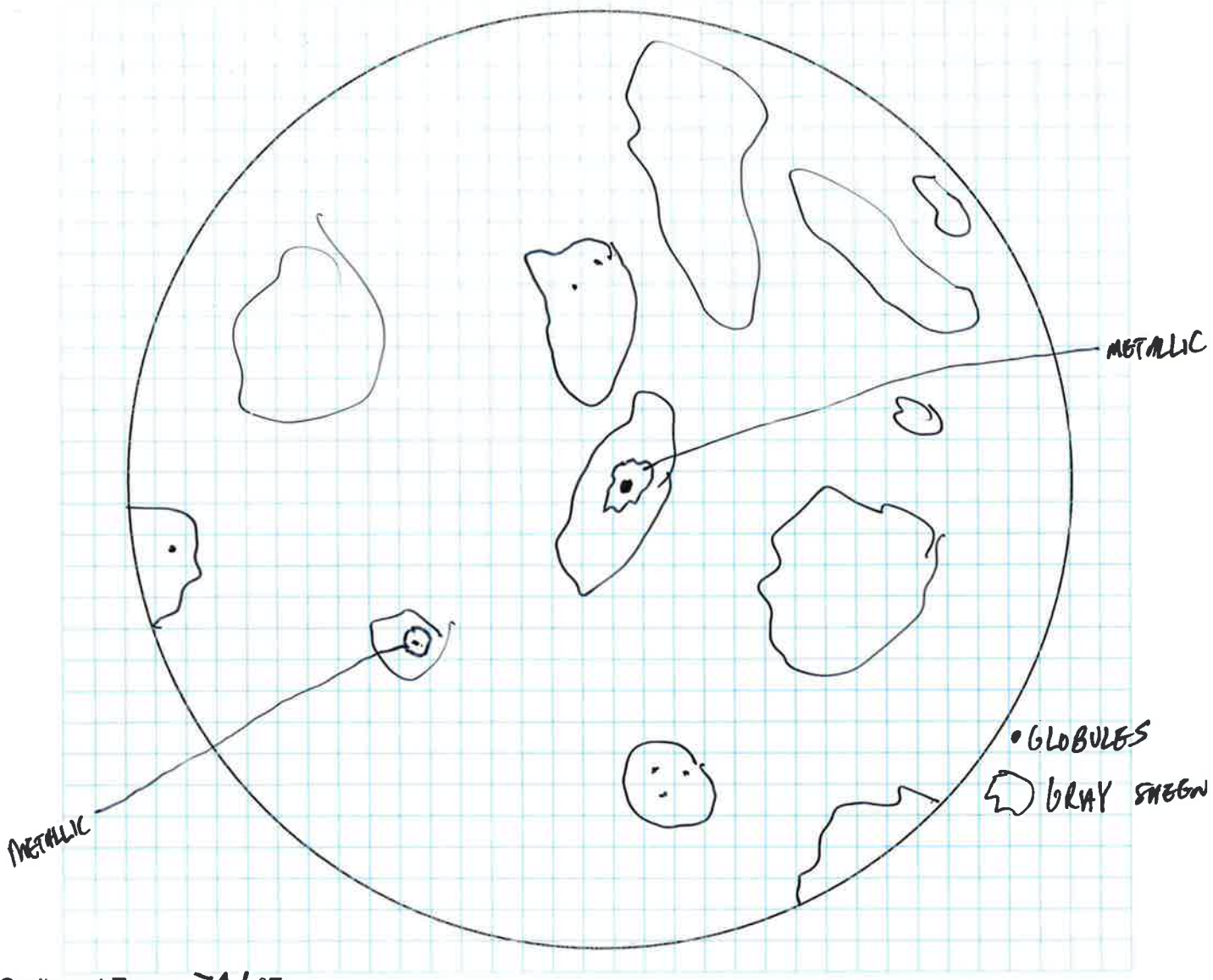
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/9/12

Observation Form

Temperature: 75 °F
Beaker #: 1
Mile Post: 10.75

Observation:
- ☒ Prior to agitation
- ☐ After 1 Stir
- ☐ After 3 stirs



Sediment Temp: 74.6 °F
Surface Water Temp: 75.1 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☒ Silver
- ☒ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☒ Fluoresced Oil 2 AREAS LESS THAN DIME SIZE
- ☒ Fluoresced globules 8 GLOBULES UP TO 1/8" DIAMETER

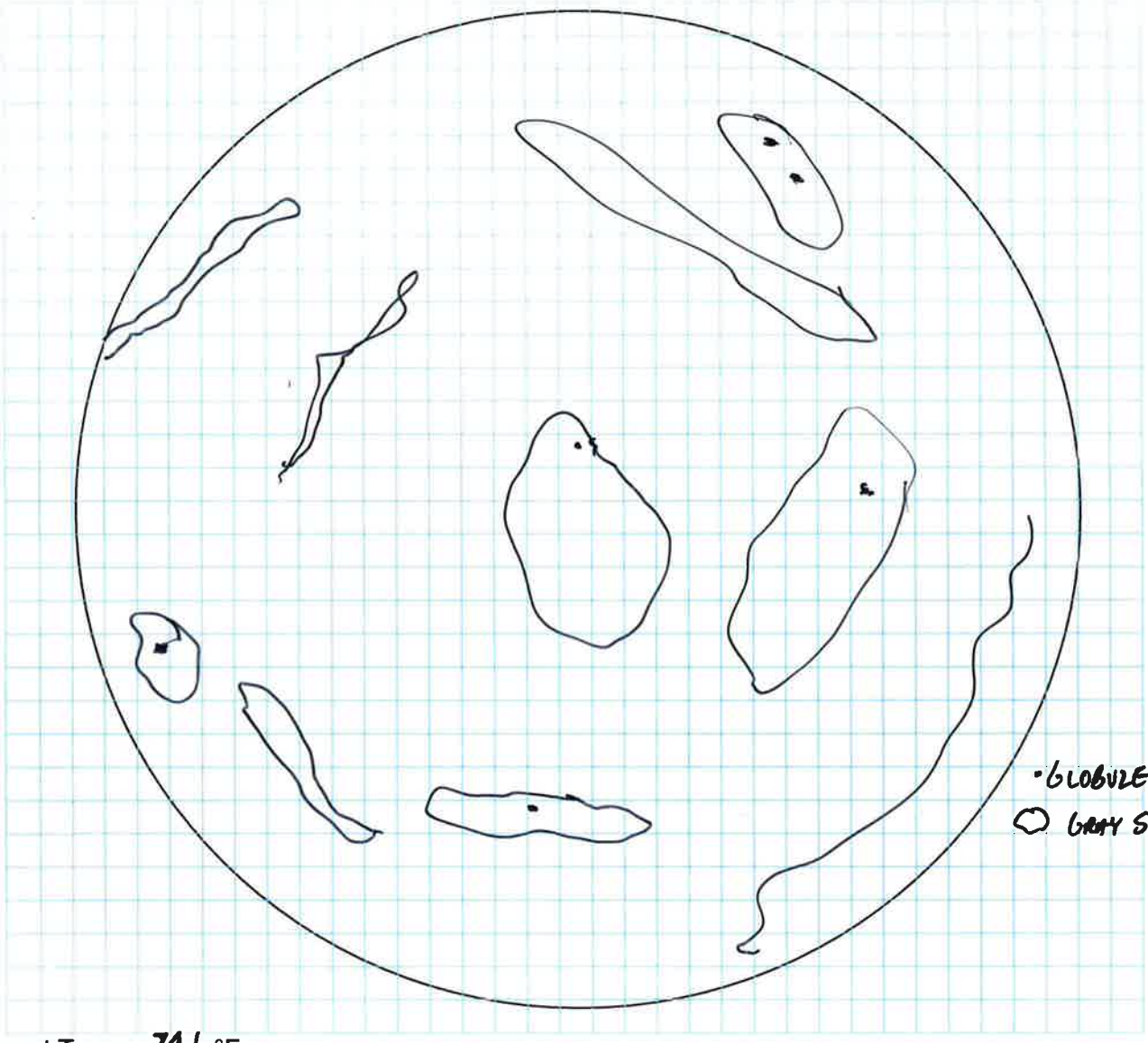
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/10/12

Observation Form

Temperature: 75 °F
Beaker #: 21
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☒ After 1 Stir
- ☐ After 3 stirs



Sediment Temp: 74.6 °F

Surface Water Temp: 75.1 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☒ Fluoresced Oil SEVERAL AREAS COVERING ~ 40% OF SURFACE AREA
- ☒ Fluoresced globules 3 PINHEAD SIZED GLOBULES

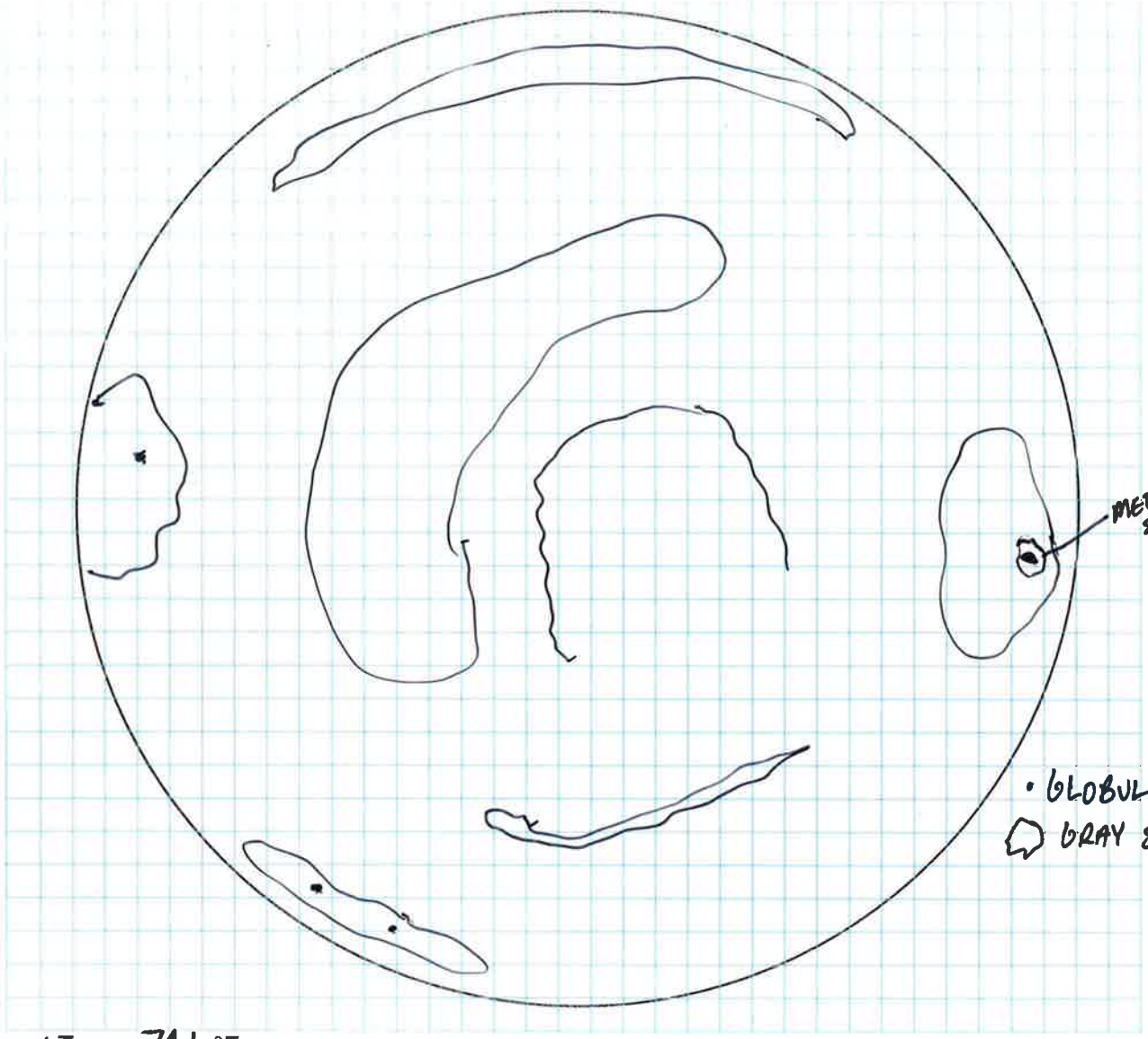
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/10/12

Observation Form

Temperature: 75 °F
Beaker #: 1
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☐ After 1 Stir
- ☒ After 3 stirs



Sediment Temp: 74.6 °F

Surface Water Temp: 75.1 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☒ Silver
- ☒ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☒ Fluoresced Oil COVERED ~ 75% OF SURFACE AREA
- ☒ Fluoresced globules 1 PIN HEAD SIZE GLOBULE

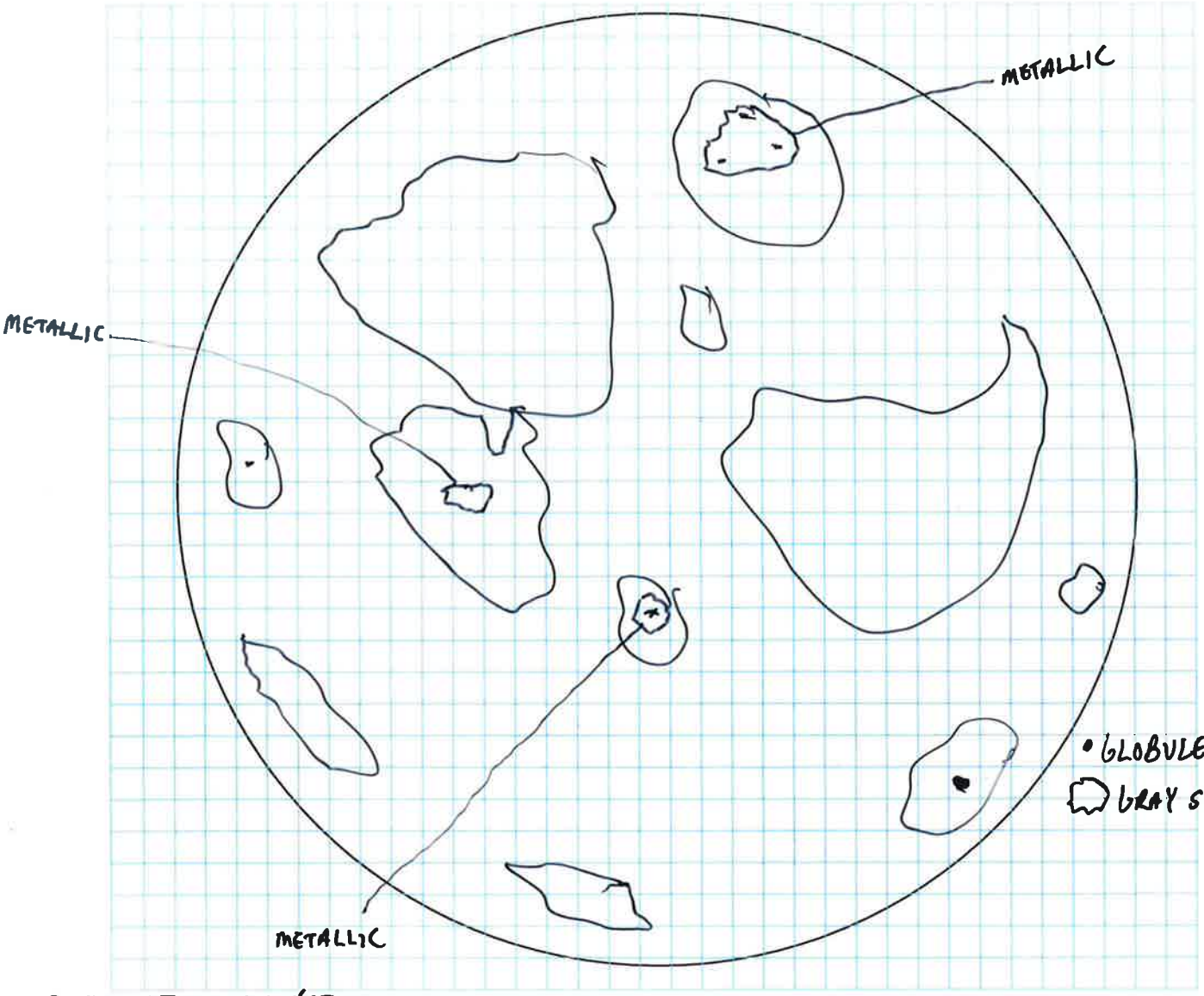
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/10/12

Observation Form

Temperature: 75 °F
Beaker #: 2
Mile Post: 10.75

Observation:
- ☒ Prior to agitation
- ☐ After 1 Stir
- ☐ After 3 stirs



Sediment Temp: 76.0 °F

Surface Water Temp: 76.2 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☒ Silver
- ☒ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☒ Fluoresced Oil LESS THAN 10% OF SURFACE AREA
- ☒ Fluoresced globules 5 PINHEAD SIZED GLOBULES

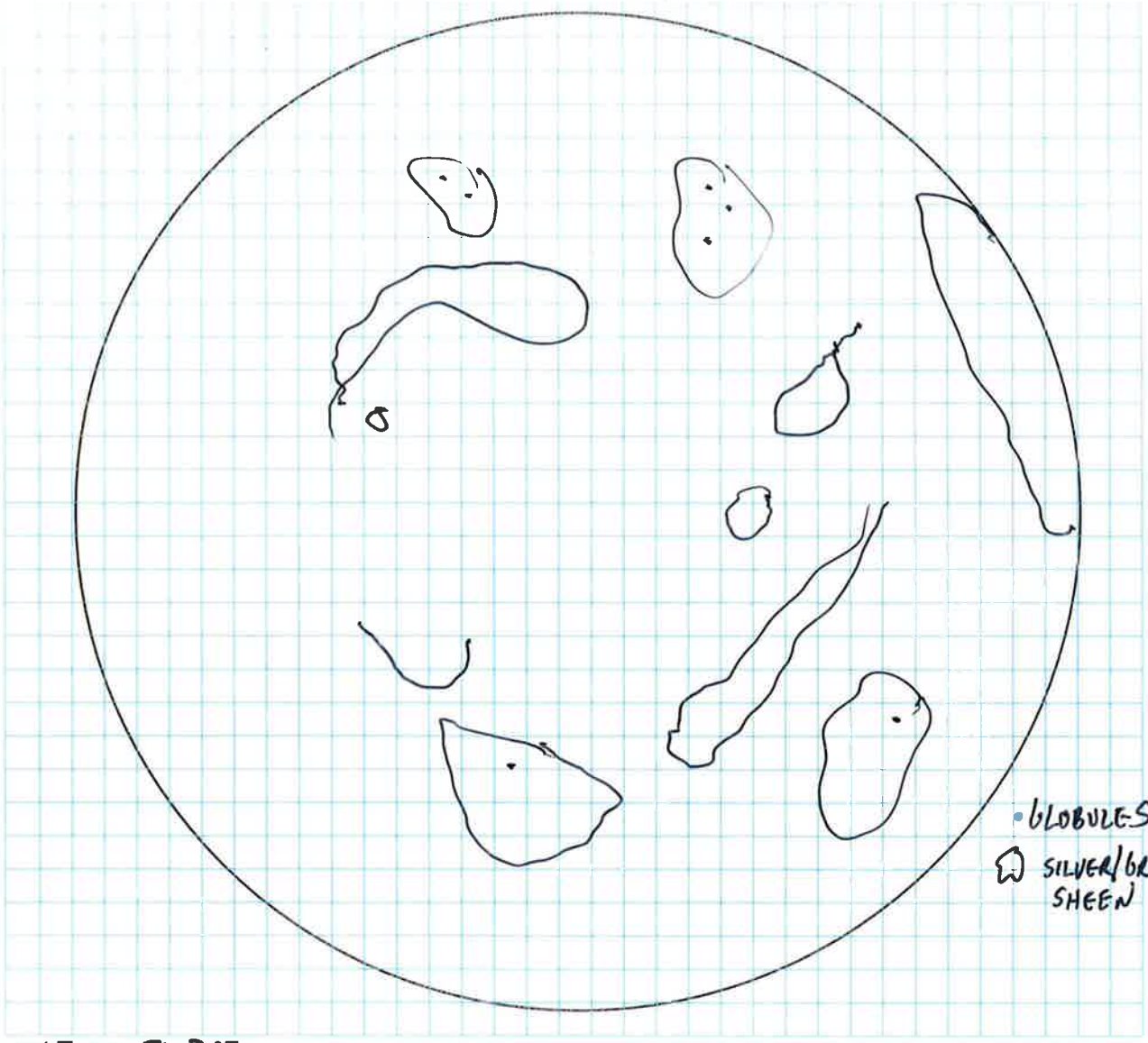
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: [signature] Date: 1/10/12

Observation Form

Temperature: 75 °F
Beaker #: 2
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☒ After 1 Stir
- ☐ After 3 stirs



Sediment Temp: 76.2 °F

Surface Water Temp: 76.0 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☒ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☒ Fluoresced Oil COVERING ~ 25 % OF SURFACE AREA
- ☒ Fluoresced globules 4 PINHEAD SIZED

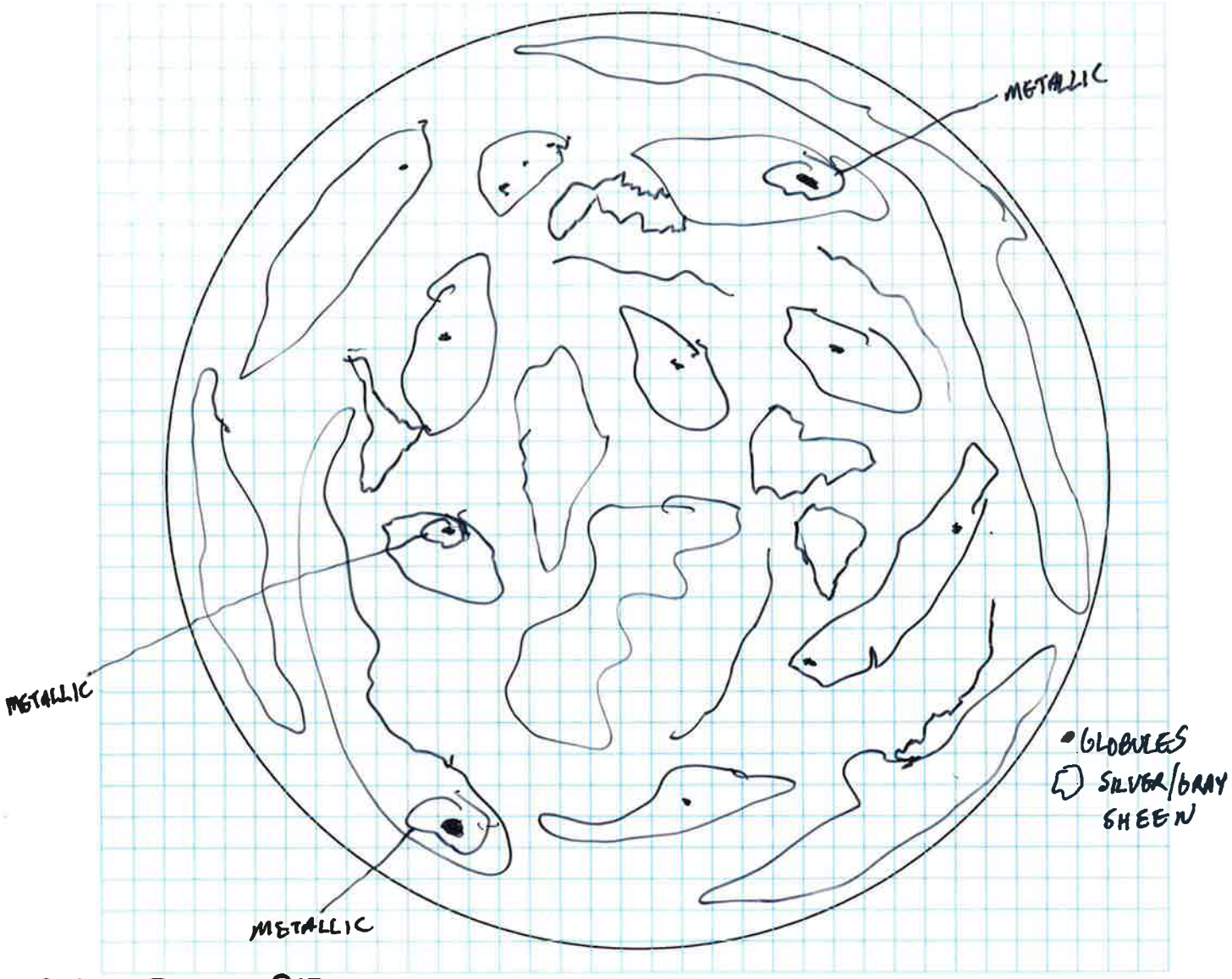
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/10/12

Observation Form

Temperature: 75 °F
Beaker #: 2
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☐ After 1 Stir
- ☒ After 3 stirs



Sediment Temp: 76.2 °F

Surface Water Temp: 76.0 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☒ Silver
- ☒ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☒ Fluoresced Oil COVERING ~ 60% OF SURFACE AREA
- ☐ Fluoresced globules 10 GLOBULES UP TO 1/8" DIAMETER

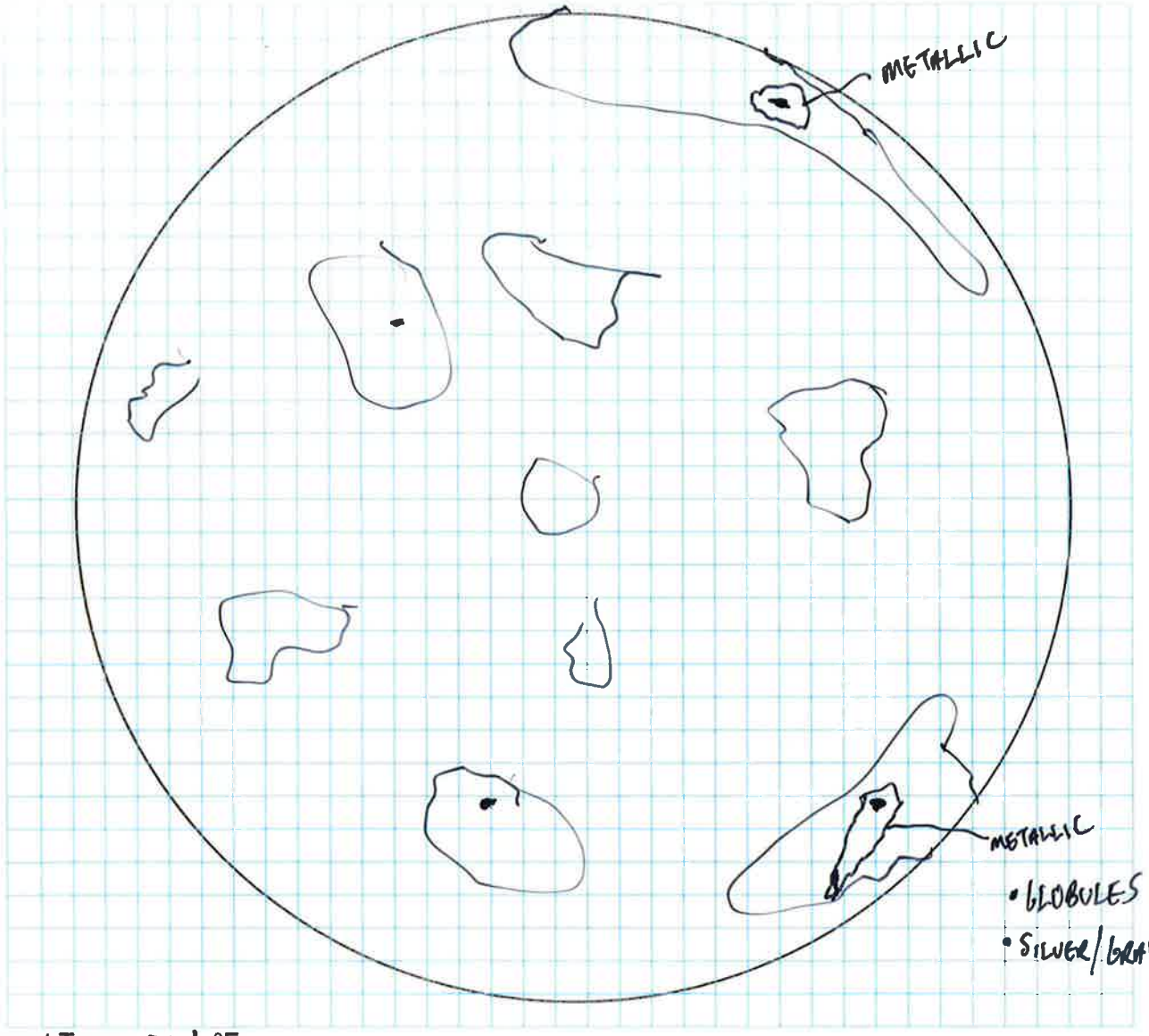
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/10/12

Observation Form

Temperature: 75 °F
Beaker #: 3
Mile Post: 10.75

Observation:
- [x] Prior to agitation
- [ ] After 1 Stir
- [ ] After 3 stirs



Sediment Temp: 76.1 °F

Surface Water Temp: 75.3 °F

Visible Light Sheen:
- [ ] None
- [x] Gray
- [x] Silver
- [x] Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- [ ] None
- [x] Fluoresced Oil LESS THAN 5% OF TOTAL SURFACE
- [x] Fluoresced globules 3 GLOBULES (PIN HEAD SIZED)

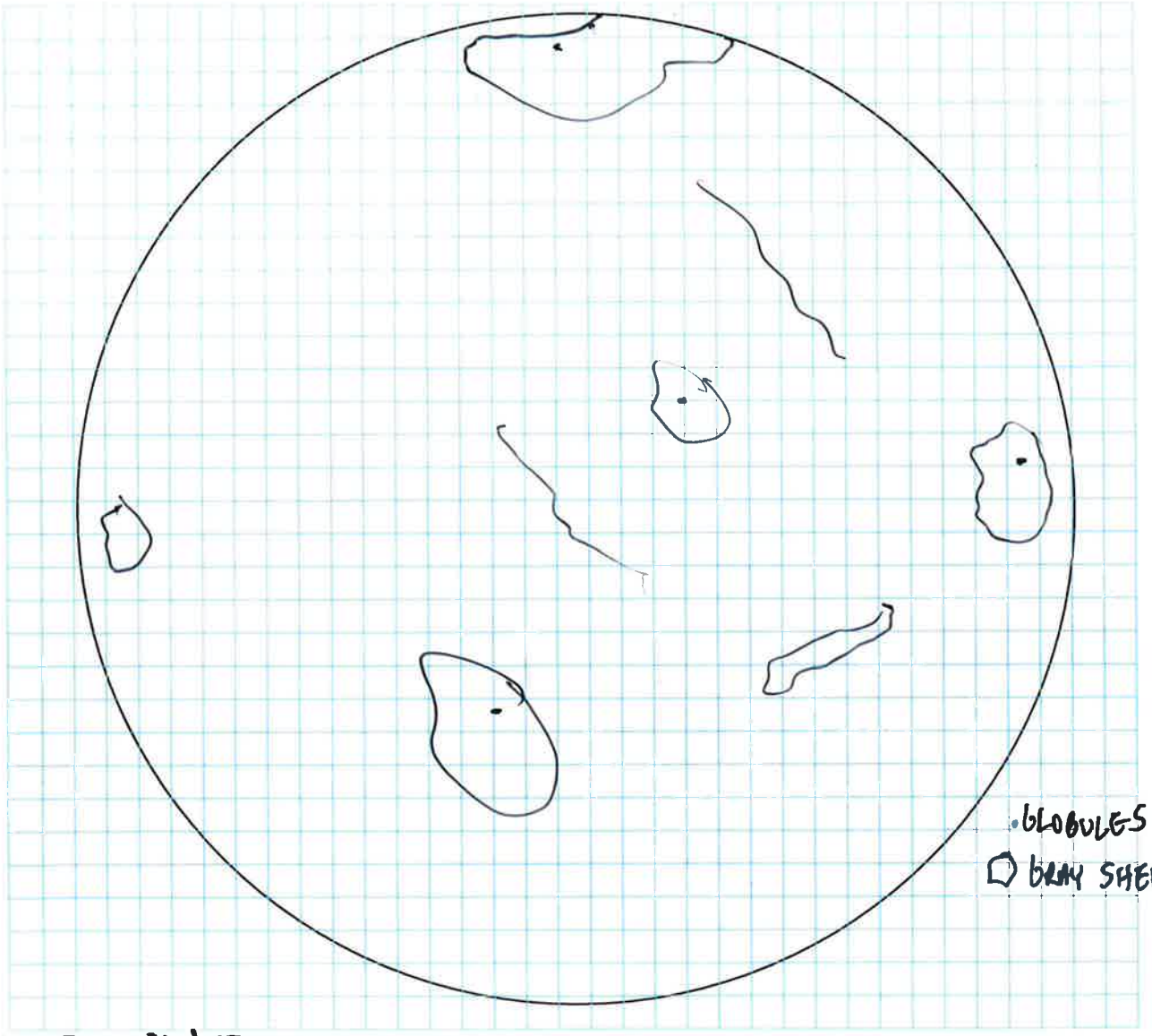
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/10/12

Observation Form

Temperature: 75 °F
Beaker #: 3
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☒ After 1 Stir
- ☐ After 3 stirs



Sediment Temp: 76.1 °F

Surface Water Temp: 75.3 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☐ Silver
- ☐ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☒ Fluoresced Oil LESS THAN 5% OF TOTAL SURFACE AREA
- ☒ Fluoresced globules 3 PINHEAD SIZED GLOBULES

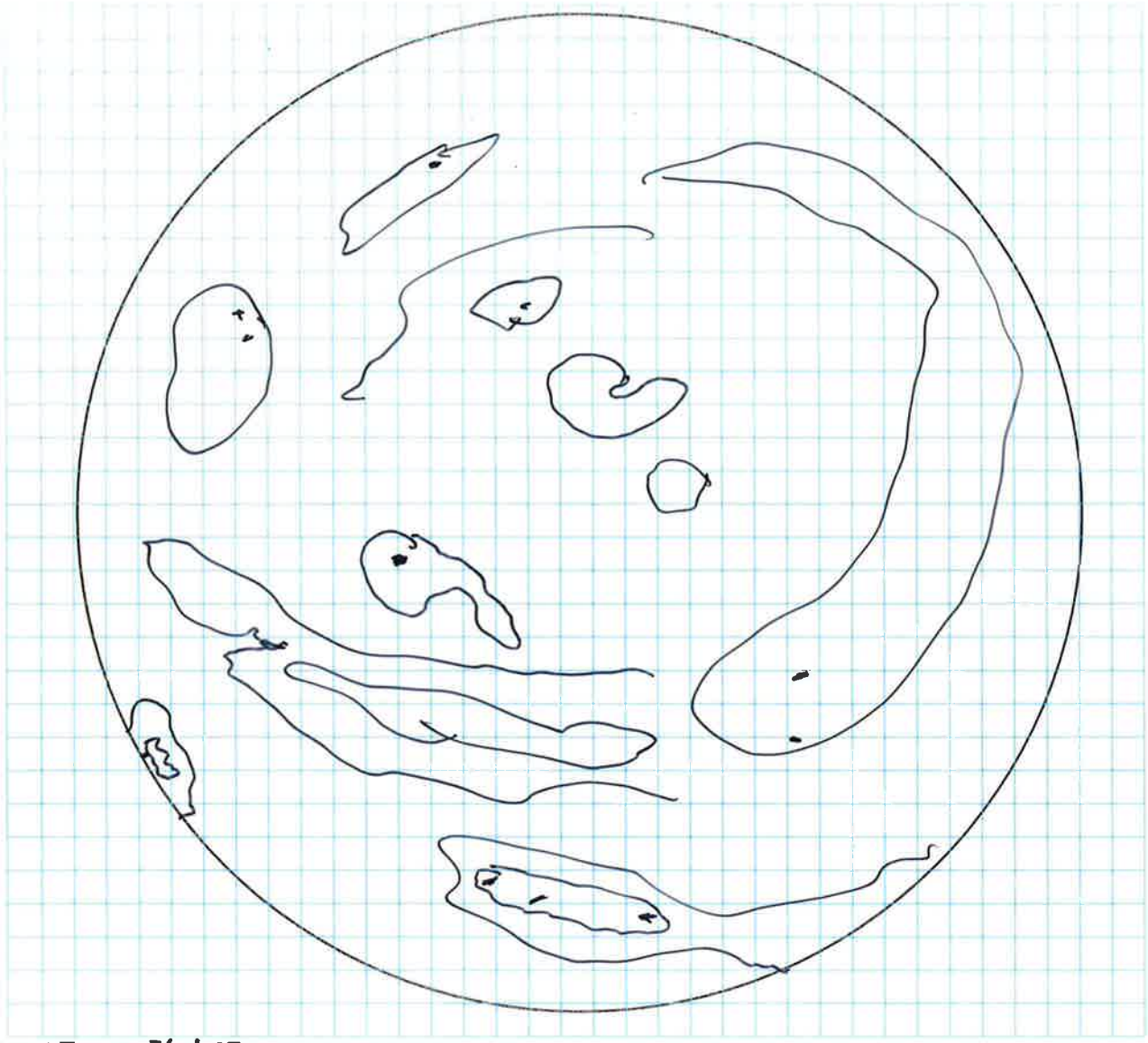
% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: _____ Date: 1/10/12

Observation Form

Temperature: 75 °F
Beaker #: 3
Mile Post: 10.75

Observation:
- ☐ Prior to agitation
- ☐ After 1 Stir
- ☒ After 3 stirs



Sediment Temp: 76.1 °F

Surface Water Temp: 75.3 °F

Visible Light Sheen:
- ☐ None
- ☒ Gray
- ☒ Silver
- ☒ Metallic / transitional

Percent Sheen:
n (# whole squares) = _____
m (# partial squares) = _____
SA (Surface Area) = _____ in^2
SA= (n x 0.036) + (m x 0.018)

Globules:
Count # _____
Ave. Dia.: _____ in.

UV Light Sheen:
- ☐ None
- ☒ Fluoresced Oil ~60% OF TOTAL SURFACE AREA
- ☒ Fluoresced globules 5 PINHEAD SIZED GLOBULES

% = SA/ 26.4= _____%
= (n + m) / 727 x 100 = _____%

Sign Off: [signature] Date: 1/10/12