CITY OF NEW BRUNSWICK
COMPREHENSIVE TECHNICAL ASSISTANCE (CTA)
MONTHLY PROGRESS REPORT

TO: FRANK J. MARASCIA

FROM: HOWARD J. WOODS, JR., P.E.

SUBJECT: MONTHLY REPORT FOR FEBRUARY 2014

DATE: MARCH 14, 2014

I. PERFORMANCE LIMITING FACTORS DEFINED IN THE COMPREHENSIVE PERFORMANCE EVALUATION

A. ADMINISTRATION – POLICIES ADMINISTRATION (A)

1. Adopt Plant Performance Goals

During the month of February, the gravity filters were not used to produce water. All filtration operations were shifted to the membrane filters and the City continued to purchase water from the East Brunswick Water Department.

In January, Roberts Filter Services, Inc. conducted a detailed inspection of the gravity filters. A copy of the final report, which was received in February, is provided as Attachment A to this report. The inspection included multiple excavations of each filter to identify any issues with the quantity and stratification of media. In addition, samples of sand and anthracite were collected from each filter for physical and chemical analysis. Filter Nos. 1 through 5 all have media depths that are uniform and the sand and anthracite are close to the original installation specification for effective size and uniformity. These filters can be returned to service.

Filter No. 8 has an apparent defect in either the media retention cap or the underdrain and will need to be rebuilt before it can be returned to service. Filter No. 7 has a potential leak in the air supply line for the air wash system. This has caused a small depression in the filter depth near the air supply line. Otherwise, the media in this filter is uniform and close to the original specification. Further investigation of the possible leak in the air supply will need to be done before this filter can be returned to service. The sand layer in Filter No. 6 is uneven and this may be the result of partial plugging in the media retention cap or underdrain. In addition, the effective size of the anthracite is below specification. The overall depth of the media is close to specifications and the filter could be returned to service with additional monitoring.

Laboratory results show some manganese deposition on the media, which is to be expected after approximately eleven years of service. The media is reaching the end of its expected service life and should be replaced within a year or two.

All filtered water effluent valves have now been replaced. The old and unused surface wash sweeps have been removed from the filter boxes. A plan is being developed to replace the filter-to-waste, influent, backwash and drain line valves and the older valve actuators that remain in service.

Through November 2013, the operation of the filters was stabilized and performance at IFE turbidity levels consistently below 0.3 NTU was achieved. However, better performance is possible. The objective is to improve filter performance to the point where IFE turbidity is consistently below the target of 0.1 NTU. Filter Nos 1 through 5 will be returned to service in March and additional work to develop refined performance goals will be undertaken. Once the filtration process is optimized, work will turn toward optimizing the coagulation/sedimentation process.

2. Outdated or Inadequate Continuous Monitoring Equipment

New loss-of-head gages will be installed and calibrated in March. The old turbidimeters will be calibrated and plumbed to the filter to waste lines to give the operators real-time data on the turbidity in the filter to waste line. This will provide additional information that can be used to determine the length of the ripening period. The existing combined filter effluent turbidimeter will be relocated to a more representative location to provide an accurate measure of the combined filter effluent turbidity for only the gravity filters.

A new chlorine residual analyzer was purchased and has been installed at the influent of the chlorine contact basin for additional operational control. This monitoring point will sense a change in dose rate and will signal the operators through an alarm if the primary chlorine feed is interrupted. In addition to the residual analyzer and the alarm, a redundant chlorine feed line has been installed to this point. If there is an interruption in service in the primary line, the backup can be turned on immediately.

A more detailed evaluation of the plant SCADA system has been completed and it has been determined that the SCADA system is inadequate and should be replaced. The existing system does not have adequate redundancy to assure that the historical operating data will be properly stored for later recovery. A new System Integrator (Enterprise Automation, Inc.) has been selected and has provided the City with a proposal to phase-out the existing SCADA system and replace it with a new, state-of-the-art system. The estimated cost of the new SCADA system is $187,000 and it is expected to be placed in service in the second quarter of 2014.

3. Delayed Maintenance

The City has restructured the water treatment plant staff and designated an employee to be responsible for all maintenance planning. "Maintenance Connection" has been acquired and is being used to develop a programmed and preventative maintenance system.

4. Lack of Safety Equipment

The City requested a survey of the plant by P-OSHA. An inspection was completed and a report is pending.

B. SUPERVISION – ADMINISTRATION (A)

These organizational changes put in place through early December resolve the organizational issues identified in the CPE report.

C. WATER TREATMENT UNDERSTANDING – OPERATIONS (A)

In-service training of the plant operations and maintenance staff is now being performed by the newly installed operations staff management team. This training is also being supplemented by periodic visits by the CTA consultants.

At a loading rate of 4 gpm/sf, Filter Nos 1 through 5 have a total output capacity of 10 MGD. However, due to the effective size of the anthracite and the presence of manganese build-up on the media, throughput will be limited to 3 gpm/sf or a total of 7.5 MGD. Operational criteria will be established for the operators to govern shifts in the balance of flow between the membrane and gravity filters to maintain target water quality objectives. During challenging raw water quality conditions, a higher percentage of water could be produced in the membrane filters while in normal and favorable conditions, more water could be produced through the gravity filters. The gravity filters have significantly better life-cycle cost profiles than the membrane filters. Work on this phase of the CTA should begin in March when Filter Nos 1 through 5 will be ready to be returned to service.

After filtration operations are optimized and balanced, the CTA will focus on pre-treatment, coagulation and sedimentation operations.

D. DATA INTEGRITY – OPERATIONS (B)

A new System Integrator (Enterprise Automation, Inc.) has been selected and has provided the City with a proposal to phase-out the existing SCADA system and replace it with a new, state-of-the-art system. The existing SCADA system will remain in service for several more months and manual data recording will continue to provide a permanent record of operations until the SCADA system is replaced.

E. OPERATING GUIDELINES – OPERATIONS (B)

Work on the gravity filtration system operating guidelines will restart when the filters are placed back in service. Up-to-date operating procedures will be developed by the plant operations and maintenance staffs, with assistance from the CTA consultants, and these updated procedures will be consolidated in a living operations manual. As new procedures are developed, the manual will be expanded.

F. MAINTENANCE – MAINTENANCE (B)

The City purchased and installed replacement membranes as needed to address membranes that could not meet appropriate pressure criteria. This work is complete.

As noted above, work is progressing on the replacement of gravity filter control valves and instrumentation. The gravity filters were completely renovated in 2002.[1] Based on the results of the filter inspection, a schedule for media replacement will be developed.

G. REPRESENTATIVE SAMPLING – OPERATIONS (B)

A new CFE turbidity monitoring location will be created to provide a more representative CFE result for the gravity filters prior to introduction of water from the membrane filters. Once this is

[1] This is a correction. A previous report indicated that the filter renovations were complete in 2005. This work was done in 2002.

done, independent CFE reports for the membrane filters and for the gravity filters will be prepared. This will provide better operational control for the plant as a whole. The existing combined CFE monitoring point will be maintained for operational control as this point does provide a representative monitoring point for all water produced and delivered from the plant. These modifications will be coordinated with the SCADA improvements and the gravity filter improvements.

ATI probe-type turbidimeters will be installed at the outlets to the two sedimentation basins. The devices have been received on site. The purpose of these two monitoring points is to give the operators real-time knowledge of the quality of the effluent leaving each individual sedimentation basin prior to the addition of lime. This will provide better operational control of the sedimentation process. The current monitoring point will continue to provide data that reflects the turbidity of the combined settled water after lime addition and prior to filtration.

A sample pump and pH probe will be installed to link pH to the operation of the streaming current monitor to provide better control of the coagulation process.

The grab sampling routine for the plant will be reviewed after the replacement of the SCADA system. The current grab sampling schedule is redundant and nearly all of this work should be eliminated. However, this cannot be completely done until a reliable data historian is available in the SCADA system. At this point in time, the grab sampling routine provides a useful backup to the preferred automated monitoring system.

H. COMPENSATION – ADMINISTRATION (B)

This item has not yet been evaluated in the CTA. Changes in the compensation system must reflect the unionized nature of the workforce and the fact that these are public employees. A pilot proposal for training and licensing incentives is currently being developed by the utility Director.

II. ADDITIONAL ISSUES DEFINED DURING THE CTA

A. LIME ADDITION RELIABILITY

During the CTA, reliability issues associated with the lime feeders have been identified. Alternatives to lime addition will be reviewed during the CTA to determine the best way to adjust pH. Caustic soda, which is available at the plant, may provide a more reliable pH adjustment process and may be desirable even though the chemical is generally more costly. An evaluation of the pH adjustment process and its impact on distribution system corrosion control will be done during the CTA.

B. POTASSIUM PERMANGANATE FEED

Inspections of various elements of the plant show some evidence of manganese staining. The gravity filter inspections show that manganese has deposited on the media. The presence of a manganese coating on the media is likely helping to remove manganese in the treatment process and this would serve to reduce the potential for customer complaints. Consideration is being given to the possible need to reactivate the use of potassium permanganate at the intakes and this could be coordinated with gravity filter media replacements. Potassium permanganate was used at the plant many years ago to control manganese, but its use was suspended.

Attachment A

Filter Inspection Report

Roberts Services, Inc.

SERVING THE WATER COMMUNITY

NEW BRUNSWICK, NEW JERSEY

ROBERTS CONTRACT 4046-S

FILTER INSPECTION REPORT

FEBRUARY 28, 2014

SUBMITTED TO:

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Inspection Report
New Brunswick

The writer visited the above treatment on January 20 and 21, 2014 as part of a contract to inspect the eight gravity filters. The objective of the inspection was to assess the condition of the filters and to determine if any mechanical conditions exist that can effect filtered water quality. The inspection was carried out by personnel from Roberts Services under the direction of Andrew Taylor and the writer.

Background

The plant source is Delaware and Raritan Canal supplemented by raw water from the Weston Mills Pond. Issues related to performance and water quality are discussed in the report on the Comprehensive Performance Evaluation (CPE) dated August 27-30, 2013 prepared by Process Applications, Inc. from Fort Collins, CO. The filter inspections are part of the Comprehensive Technical Assistance (CTA) referenced in that report.

The design capacity for the gravity filter plant is 16 mgd max (11,100 gpm) as reported in the CPE. That equates to a nominal rate of 4 gpm/ft^2 with all filters in service. Per the CPE the gravity filter plant does not operate at the design capacity but is used as a variable source to supplement the production from the membrane filter plant in meeting system demand. Per the CPE, filters are taken out of service or brought into service and the filtration rate is varied as demand requires.

The filter media profile as defined in Leopold correspondence No. M1-3354 called for 12" sand, effective size (e.s.) 0.45-0.55 mm, uniformity coefficient (u.c) 1.5; and 18" anthracite, e.s. 0.80-0.90 mm, u.c. 1.4. One additional inch depth of each material was called for as allowance for skimming. That profile was called for as part of the rebuilding of the filters completed in 2004. A profile with those sizes is atypical of a dual media design. Anthracite of the size called for here would typically be installed with sand e.s of 0.35-0.45 mm or smaller. Typically sand with an e.s. of 0.45-0.55 mm would have anthracite with as e.s. of 0.9-1.0 mm. Such profiles are selected to allow approximately equal percent expansion of the two mediums during backwash. Smaller anthracite over larger sand would result in greater expansion of the anthracite at any given backwash rate, but would give assurance of complete separation of the media after backwash. The underdrains are Leopold Universal air/water design with IMS cap. Air wash is included as part of the backwash sequence; the original surface wash units are still present but not used.

Work Accomplished

Four filters were drained and ready for inspection on the first day; the remainder were drained and inspected on the second day. Inspections consisted of visual evaluations of the equipment and basin conditions, and observation of the bed surface for cracks, mounding, depressions or mudballs. Diagrams of each filter are included at the end of the report for reference and the original inspection checklists with diagrams are included in Appendix 3.

The filters had been taken out of service well before the inspections. The amount of service time after backwash for each filter prior to removal from service was unknown. The results are summarized below:

Filter	Level?	Mounded?	Compacted?	Mudballs?	Intermixed?	Depressions?
1	Yes	No	No	No	No	No
2	Yes	No	No	No	No	No
3	Yes	No	No	No	No	No
4	Yes	No	No	No	No	No
5	Yes	No	No	No	No	No
6	Yes*	No	No	No	No	No
7	Yes**	No	No	No	No	Yes
8	Yes**	No	No	No	No	Yes

*The bed surface was level but the sand level was uneven.

**The surface was level in all areas except at the depression.

The distance between the top of the washwater trough weirs and the top of the media were recorded in 8 locations in each filter and is defined in this report as the freeboard. A straight edge was laid across the trough to make the measurement. Test holes were dug by hand to check subsurface bed conditions, collect media samples and determine media depths, again in eight locations.

The measurements are summarized below:

Filter	Sand depth		Anthracite depth		Freeboard		Samples taken
	Range	Average	Range	Average	Range	Average	
1	11.5”-12”	11.9	16”-18”	17.6	31”-32”	31.8	Yes
2	12”-13.5”	12.7	16”-18.5”	17.7	28”-31.5”	29.3	Yes
3	13”-14”	13.3	18”-19”	18.1	27.5”-29”	28.2	Yes
4	14”-15”	14.1	16”-18”	16.3	28.5”-29.5”	29	Yes
5	12”-13”	12.9	18”	18	30”-30.5”	30.3	Yes
6	12”-15”	12.9	19”-20”	19.4	28”-29”	28.4	Yes
7	11.5”-13”	12.7	18”-19”	18.3	30.5”-32”	31	Yes
8	11”-12”	11.9	11”-13”	12.5	35.5”-37”	36.7	Yes

The measurements at each location are shown on the diagrams included in Appendix 1 at the end of the report.

Eight samples of anthracite and sand were taken from each filter. Each of these samples was a composite of material taken from different elevations in each medium layer. Anthracite was taken at depths of 6" and 12" below the surface and 1"-2" above the interface. Sand was taken at depths of 3" and 9" below the interface. The eight samples of each medium in each filter were visually inspected at Roberts' office and no variation was found. These eight samples were then composited to produce one anthracite and one sand sample from each filter for sieve analysis. In addition, one anthracite and sand samples was taken from filter eight for microscopic analysis. The samples were sent to Bowser-Morner, Inc. for analysis.

The results of the analyses are as follows:

	Anthracite		Sand	
Filter	Effective size	Uniformity coefficient	Effective size	Uniformity coefficient
1	0.89	1.2	0.57	1.2
2	0.88	1.4	0.54	1.2
3	0.78	1.4	0.54	1.3
4	0.87	1.3	0.52	1.3
5	0.94	1.4	0.50	1.3
6	0.65	1.8	0.53	1.2
7	0.87	1.3	0.51	1.3
8	0.70	1.7	0.50	1.3

Copies of the reports are included in Appendix 2.

A microscopic analyses of the sand and anthracite from filter 2 was done by Red River Laboratories of Oklahoma City, OK. The full report with pictures is included in Appendix 3.

Observations

General:

The sand and anthracite in all filters by visual appearance was clean and not stained. No compacted areas were found nor were any mudballs detected. No backwashes could be observed but the cleanliness and conditions of the media would indicate that the backwash is effective in cleaning the media. The interface between sand and anthracite in all filters was very distinct, the picture at right is representative of conditions seen in all filters. No mechanical issues were seen in Filters 1-5. Filters 6-8 do have issues that will be detailed individually.



Sand depth:

With the exception of filters 1 and 8, the sand levels measured were greater than the intended design. Filter 8 will be discussed later, filter 1 is the only filter where the elevation matched design. Minor variations were noted in depths but, with the exception of filter 6, the variations were random and inconsequential. Sand does not grind itself up as happens with anthracite and it can only increase in size if scaling conditions exist. The sand visually did not show scale formation, therefore it can only be assume that the extra sand in the other six filters was present from installation and results from the remainder of the one inch extra provided for skimming. The extra sand does not present an issue unless rapid headloss buildup or short filter service runs was a problem during operation. Those types of problems can result from the presence of fines at the interface. Such material, if present, would be impractical to remove unless headloss issues were deemed to be a serious problem.

Anthracite depth:

With the exceptions of filters 4 and 8, the anthracite levels were acceptably close to the intended design. Anthracite is a friable material and will grind itself up over time with vigorous air wash, resulting in loss of materials through generation of fines. A typical loss of 0.5”-2.0” per year can be expected so it is somewhat unusual that the levels are where they are unless the filters have been topped off with new anthracite.

The level in filter 8 is due to mechanical conditions that will be discussed later. The lower level in filter 4 did not appear to be the result of any backwash or mechanical issues. That filter has the highest sand depth and it is possible that bed expansion during cold water periods resulted in enough loss of anthracite to keep the total bed depth in line with the rest of the filters.

Filter Media Analyses:

The evaluation from the microscopic analysis was as follows: “The material is discolored due to Fe, Mn and organic build up. The DWL/Acid Solubility of the anthracite was high at 3.2%. The sand was as expected lower at 1.9%. The Mn content is very high at 6590 mg/kg and the Fe content is moderate to high at 643 mg/kg. The Fe content on the sand was still high at 446 mg/kg.lower at 1.9%.”

The high acid solubility is most likely accumulated alum, manganese oxide and ferric solids, which may in part have been the normal result of the prior service run. Again, the amount of service time prior to inspection is unknown. The ferric content in the sand is somewhat of a concern since the removal is expected to occur in the anthracite and marginally at the surface of the sand. Accumulation in the sand may indicate less than optimum conditioning of solids for filtration.

Per the CPE, “The chemical feed facilities at each of the raw water pump stations were once used for potassium permanganate chemical feed, but they are now inoperable.” The manganese content is probably due largely to that feed. Any additional content would be oxidized material from the source. Manganese oxide scale on filter media under such conditions is normal and beneficial in completing the

oxidation of any soluble manganese during filtration. The material can be removed by chemical cleaning, however if manganese is an issue, removal of that coating may cause higher filtered water values.

The sieve analyses for the sand showed all values within the original specification; there are no issues with the sand. The analyses for the anthracite are somewhat different. In general the sieve curves all show many points below the 10% passing level, indicating fines in the media. Such material is not unusual for anthracite media that has been in service for several years. Such material can be removed by doing a strong backwash flowed by skimming the upper ½" of material. Skimming should result in a slight increase in the effective size of the media. The samples from filters 1, 2, 4 and 7 are all within original specifications and are not an issue. The sample from filter 3 was slightly below spec but should not be an issue following the recommended skimming. The sample from filter 5 was above spec and no reason for the difference was identified through the inspection process. Media samples from filters 6 and 8 were found to be out of spec and will be discussed below. Additionally, abnormalities in Filter 7 were identified and are discussed.

Filter 6:

In general filter 6 is in good condition and the surface is level, however the sand is not level and the differences in depth are not random. The sand is deepest in the front right area of the filter and tapers downward both to the left side and to the back of the filter. The only reasonable explanation for this condition would be diminished backwash flow in the front right area. Lower flow in that area would cause slightly higher flows in the rest of the filter, which would act to move sand into the front right. The larger sand size in relation to the size of the anthracite would allow greater fluidization of the anthracite, keeping the bed itself level while allowing minimal movement of the sand, particularly in warmer water conditions.

The diminished flow would result from either some plugging of the IMS cap in that area or from the buildup of material in the ends of the laterals in that area. It is not possible to determine if this condition has developed recently, has been in existence from the installation, or something in between. The only means to investigate the area would require excavation of the media in the front of the filter and removal of some of the laterals for evaluation, which would be costly. The best course may be to make more frequent inspections of this filter to include excavations to determine media depths and to monitor the performance for any indication of problems. Excavation could be done if the problem gets worse or performance deteriorates.

The anthracite effective size is well below the specification and the wide U.C. indicates issues with sizing in general. The distribution graph does not show any presence of sand, which typically can cause results like these. This analysis may be showing poor backwash flow distribution resulting in uneven media bed expansion. No other cause is available unless earlier media analyses indicated a similar problem. In any event the variation from the original specification is too great to correct by any on-site means and the filter media should be replaced. Replacement would also allow the ability to test the underdrain directly to determine if any plugging is evident.

Filter 7:



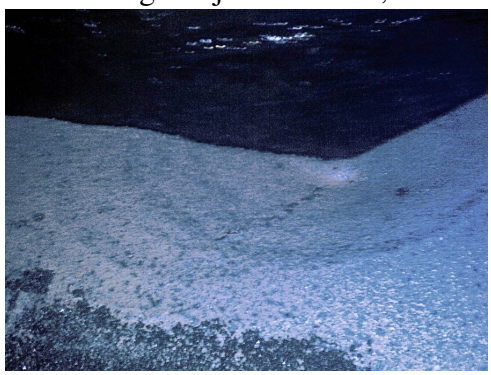
Filter 7 is in generally good condition with the exception of a 2" deep depression near the concrete encased air drop pipe as seen at right. The depression is on the side opposite the filter console. The two backwash troughs on that side also have a buildup of filter media and floc accumulated at the closed ends. No other troughs in the other filters have any such accumulation. The sand depth in that area is an inch less than design but the total media depth is consistent with 6 of the other filters, so there does not appear to have been any loss to the underdrain. It is possible that there is a leak on the air drop, possibly at the joint between the pipe and the underdrain, which would continue to bubble air during the water-only phase of the backwash. The other concern would be that if there is an opening in the pipe higher in the media it would provide a direct path to the underdrain.

It is not possible to determine when the issue developed. The only way to determine the extent of the issue is to excavate the media around the drop pipe and make an inspection of the area. Such an inspection may require the blower to be on to pressurize the pipe for leak testing.

Filter 8:

Filter 8 has a depression at the left rear of the filter 2 feet wide and 5" deep as seen on the next page. The total media depth is down 6"-7" below the other filters with the anthracite level down 5.5" below design and the sand level possibly down 0.5"-1", dependent on whether the original level in the sand matched the other filters. Assuming a total 6"-7" loss of media equates to around 200 cubic feet of media in the underdrain and downstream of the filter.

A conical depression like this develops when a breach in the underdrain or a grout joint is made, which allows media to bypass the IMS cap and seep into the laterals and flume. The area is re-leveled during a backwash and then the pressure loss across the filter again pushes material through the opening until a cone shaped depression reaches the underdrain. The process repeats every backwash, resulting in the measureable media loss.



Again it is not possible to determine when the problem developed. The most common causes of such problems are water hammer due to sudden release of an air bubble pushed into the underdrain during a backwash or a sudden hydraulic surge slamming against the back flume wall, also during a backwash. Material forced into the underdrain can be carried into the clearwell through the effluent and further downstream through the high lift pumps or at least in part remain in

flume. Material in the flume can then be forced into the underdrain laterals during subsequent backwashes, plugging them.

Unfortunately there is no way to simply repair the breach and return the filter to service. At minimum, the media at the rear quarter of the filter and the last two to three laterals would have to be removed to gain access to the flume and the underdrain. The laterals would have to be inspected for media in the primary distribution lateral, with the expectation that if media was present, it would also have been washed into the secondary distribution laterals. That condition if found would then require removal and replacement of the remaining laterals. It may be more cost-effective to rehabilitate the filter with new underdrains.

The face piping also should be flushed and the clearwell inspected for media, which is probably present given the volume of material lost. It is also possible that media was transferred to the backwash storage tank. That tank should be inspected for media, which if found could mean that media is present in the other filter underdrains. Small quantities of media would not create a problem other that the potential for such material being flushed to service in future. Large quantities could block portions of laterals causing maldistribution of backwash flow and there is no indication of such with the possible exception of filter 6.

As to the anthracite size, the loss of material in the area of the breach occurs from the bottom up, meaning the larger anthracite particles that migrate to the bottom of the layer are removed first. The anthracite layer s re-leveled as described and over time the size and distribution changes as seen in the analysis. The results indicate that the process has been going on for a long time. The sizing cannot be corrected and the media should be replaced as part of any repair.

Recommendations

1. Address the issues with filters 7 and 8 as described
2. Inspect the clearwell and tanks as described and remove any media found. Check the face piping on those filters and flush if needed. Spot check the face piping in other filters, possibly as valves are replaced, and flush if necessary.
3. Establish a program for scheduled at least yearly filter inspections to plot the conditions of the filters over time using the diagrams included in Appendix 2 of this report for comparison.
4. Replace the media in filter 6 and make more frequent inspections to determine if the condition found in the inspection worsens.
5. The fact that issues were found with filters 6, 7 and 8, which are at the end of the backwash supply header are probably not coincidental. Evaluate the potential for conditions that could cause hydraulic shock in some form, e.g. air accumulation in the backwash header, and correct if found.

Additional considerations:

The microscopic analysis of the media is an indicator of the efficiency of the pretreatment and the backwash. A similar analysis may be useful after any adjustments to treatment to see if similar results are found. Any such sample should be taken immediately after a filter backwash. Sampling can be done along with observations of backwash operations as part of future process evaluations.

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Appendix 1

Page 1 – Filter 1 Sample Location Drawing

Page 2 – Filter 2 Sample Location Drawing

Page 3 – Filter 3 Sample Location Drawing

Page 4 – Filter 4 Sample Location Drawing

Page 5 – Filter 5 Sample Location Drawing

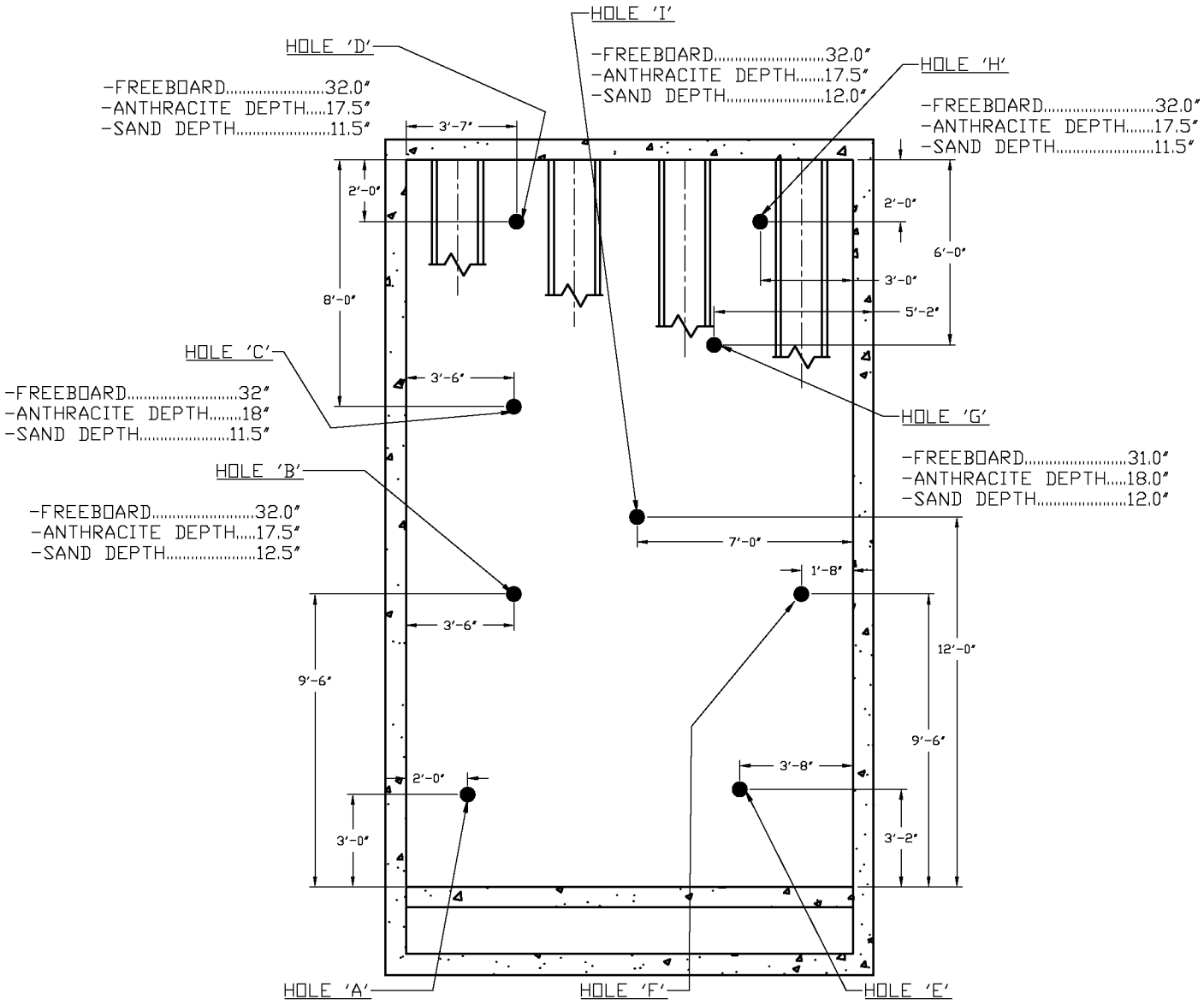
Page 6 – Filter 6 Sample Location Drawing

Page 7 – Filter 7 Sample Location Drawing

Page 8 – Filter 8 Sample Location Drawing

ROBERTS WATER TECHNOLOGIES, INC.

DARBY, PENNSYLVANIA 19023



FILTER 1

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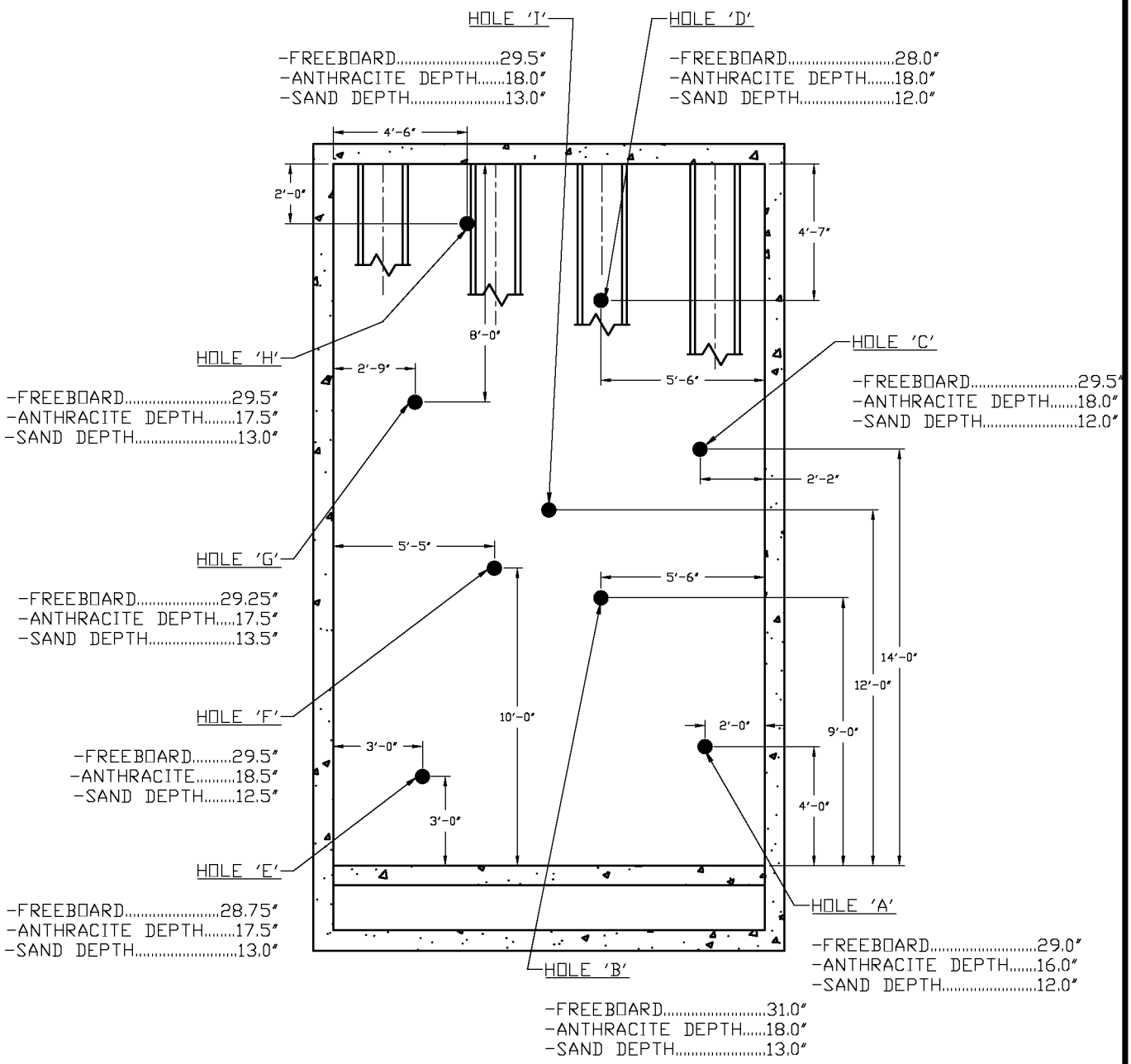
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NO.	REVISION	DATE	BY

SCALE	CONTRACT	SECTION: B	DWG. NO.
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ROBERTS WATER TECHNOLOGIES, INC.

DARBY, PENNSYLVANIA 19023



FILTER 2

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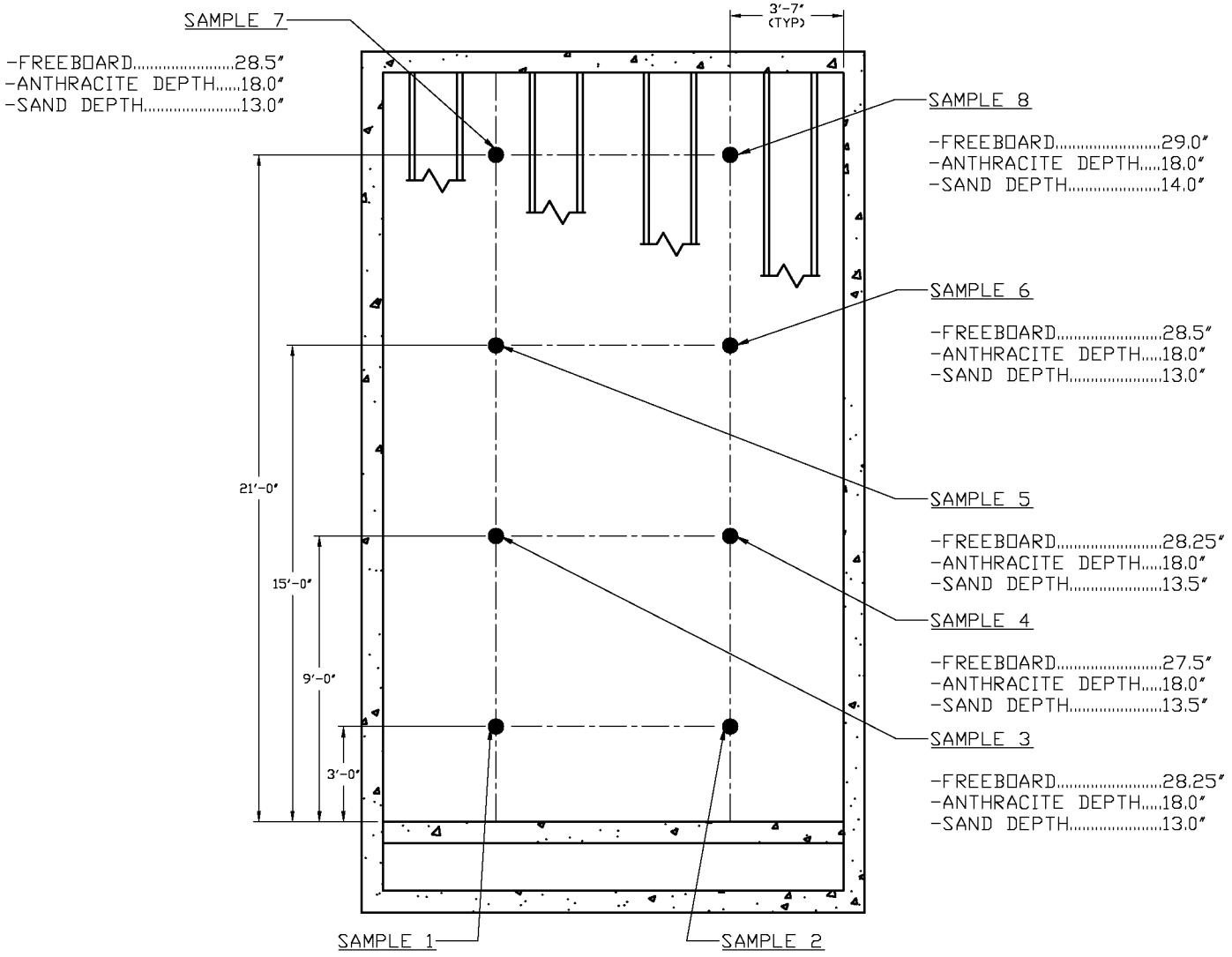
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RCM	1/24/14		

NO.	REVISION	DATE	BY

SCALE	CONTRACT	SECTION: B	DWG. NO.
0-3/16" = 1'-0"	4046-S		

ROBERTS WATER TECHNOLOGIES, INC.

DARBY, PENNSYLVANIA 19023



FILTER 3

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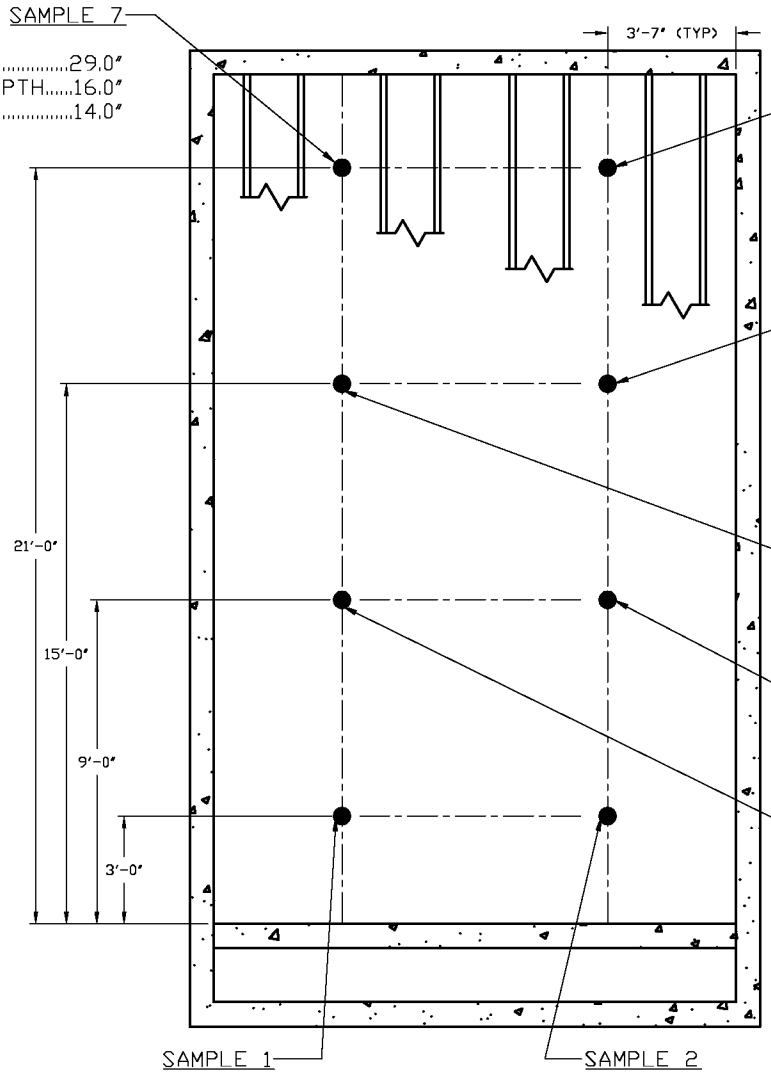
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RCM	1/24/14		

NO.	REVISION	DATE	BY

SCALE	CONTRACT	SECTION: B	DWG. NO.
0-3/16" = 1'-0"	4046-S		

ROBERTS WATER TECHNOLOGIES, INC.

DARBY, PENNSYLVANIA 19023



SAMPLE 7
-FREEBOARD.....29.0"
-ANTHRACITE DEPTH.....16.0"
-SAND DEPTH.....14.0"

SAMPLE 8
-FREEBOARD.....29.5"
-ANTHRACITE DEPTH.....16.0"
-SAND DEPTH.....14.0"

SAMPLE 6
-FREEBOARD.....29.25"
-ANTHRACITE DEPTH.....16.0"
-SAND DEPTH.....14.0"

SAMPLE 5
-FREEBOARD.....29.25"
-ANTHRACITE DEPTH.....16.0"
-SAND DEPTH.....14.0"

SAMPLE 4
-FREEBOARD.....29.0"
-ANTHRACITE DEPTH.....18.0"
-SAND DEPTH.....15.0"

SAMPLE 3
-FREEBOARD.....29.0"
-ANTHRACITE DEPTH.....16.5"
-SAND DEPTH.....14.0"

SAMPLE 1
-FREEBOARD.....28.5"
-ANTHRACITE DEPTH.....16.0"
-SAND DEPTH.....14.0"

SAMPLE 2
-FREEBOARD.....28.5"
-ANTHRACITE DEPTH.....16.0"
-SAND DEPTH.....14.0"

FILTER 4

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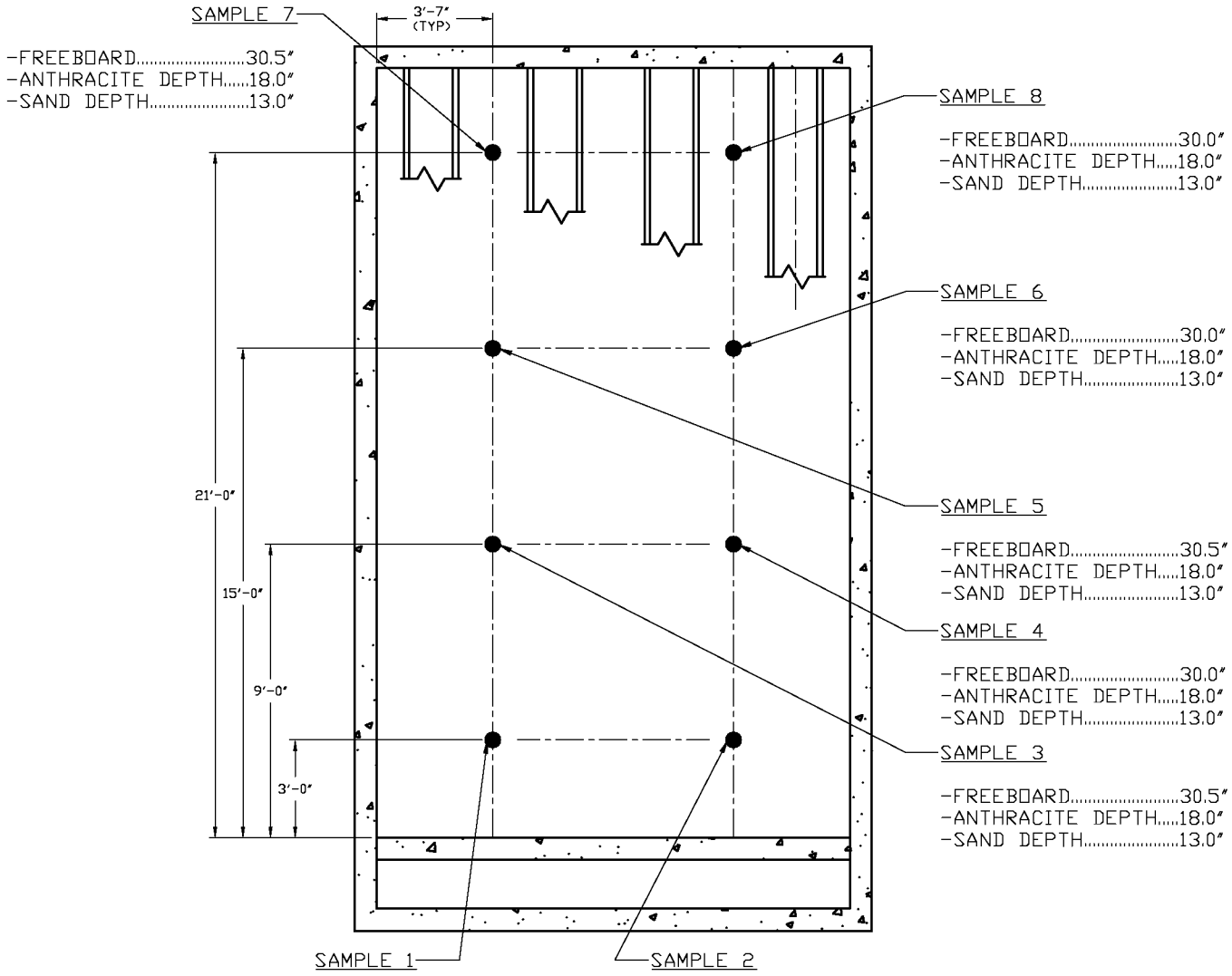
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RCM	1/24/14		

NO.	REVISION	DATE	BY

SCALE	CONTRACT	SECTION: B	DWG. NO.
0-3/16" = 1'-0"	4046-S		

ROBERTS WATER TECHNOLOGIES, INC.

DARBY, PENNSYLVANIA 19023



FILTER 5

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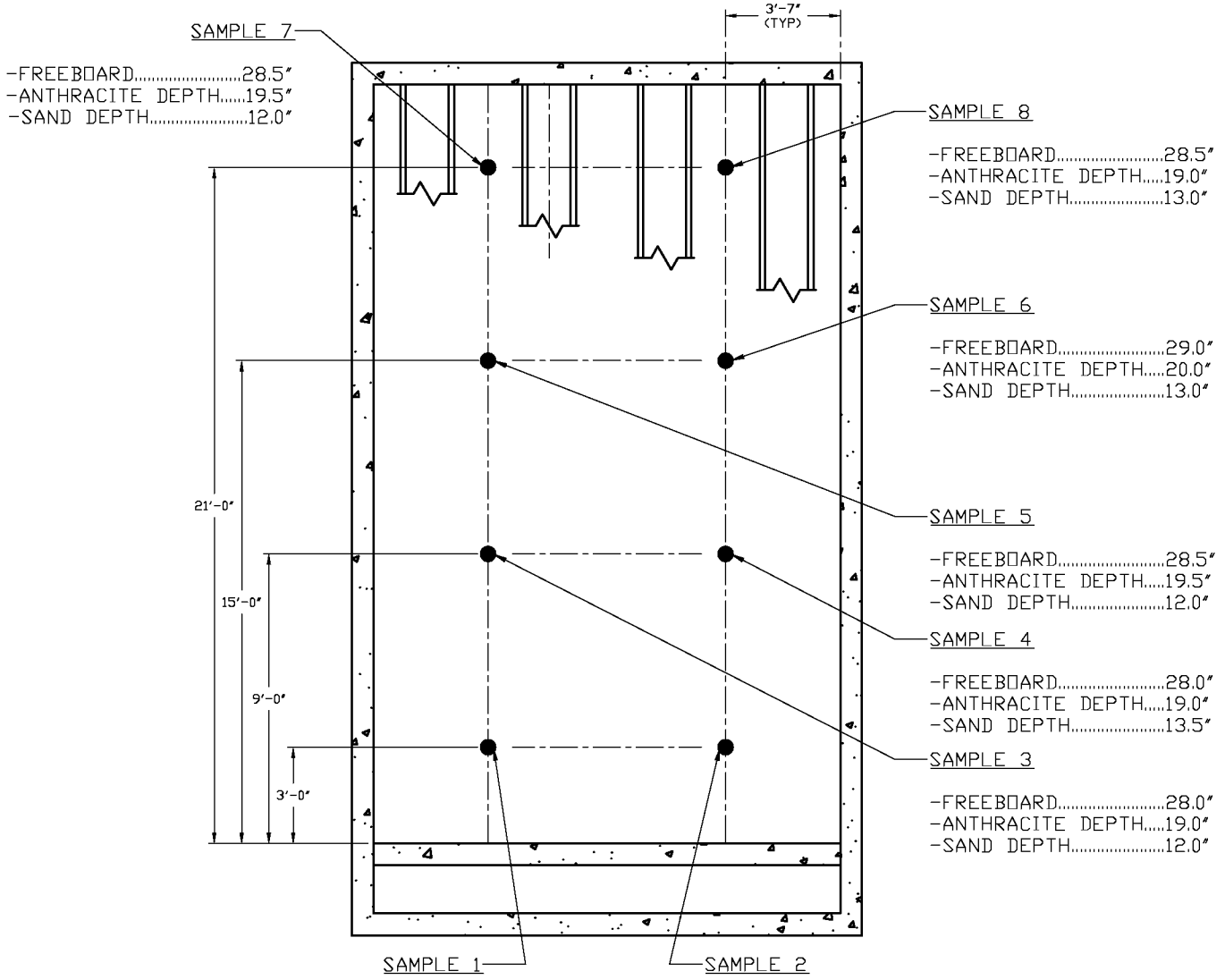
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RCM	1/24/14		

NO.	REVISION	DATE	BY

SCALE	CONTRACT	SECTION: B	DWG. NO.
0-3/16" = 1'-0"	4046-S		

ROBERTS WATER TECHNOLOGIES, INC.

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FILTER 6

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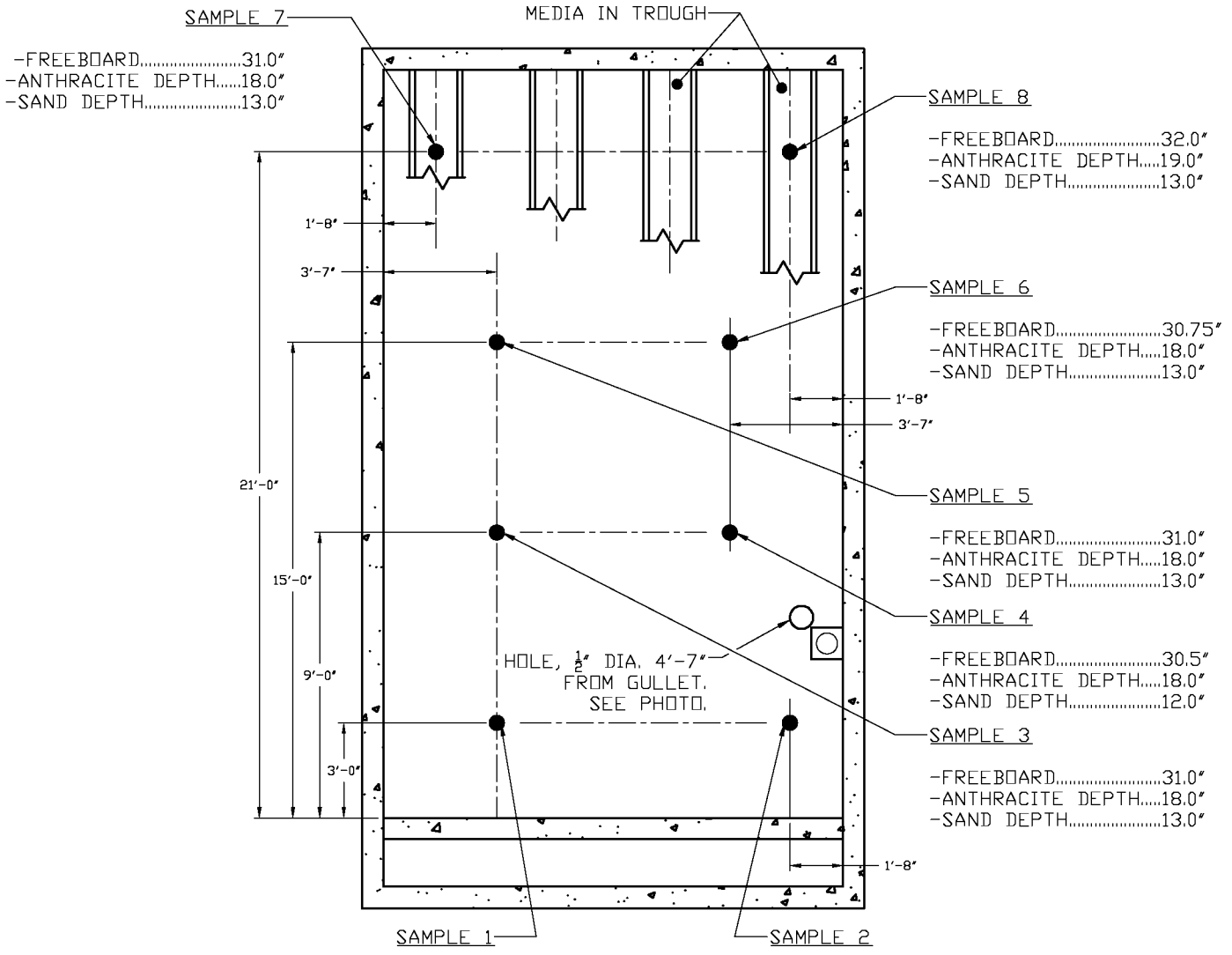
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RCM	1/24/14		

NO.	REVISION	DATE	BY

SCALE	CONTRACT	SECTION: B	DWG. NO.
0-3/16" = 1'-0"	4046-S		

ROBERTS WATER TECHNOLOGIES, INC.

DARBY, PENNSYLVANIA 19023



FILTER 7

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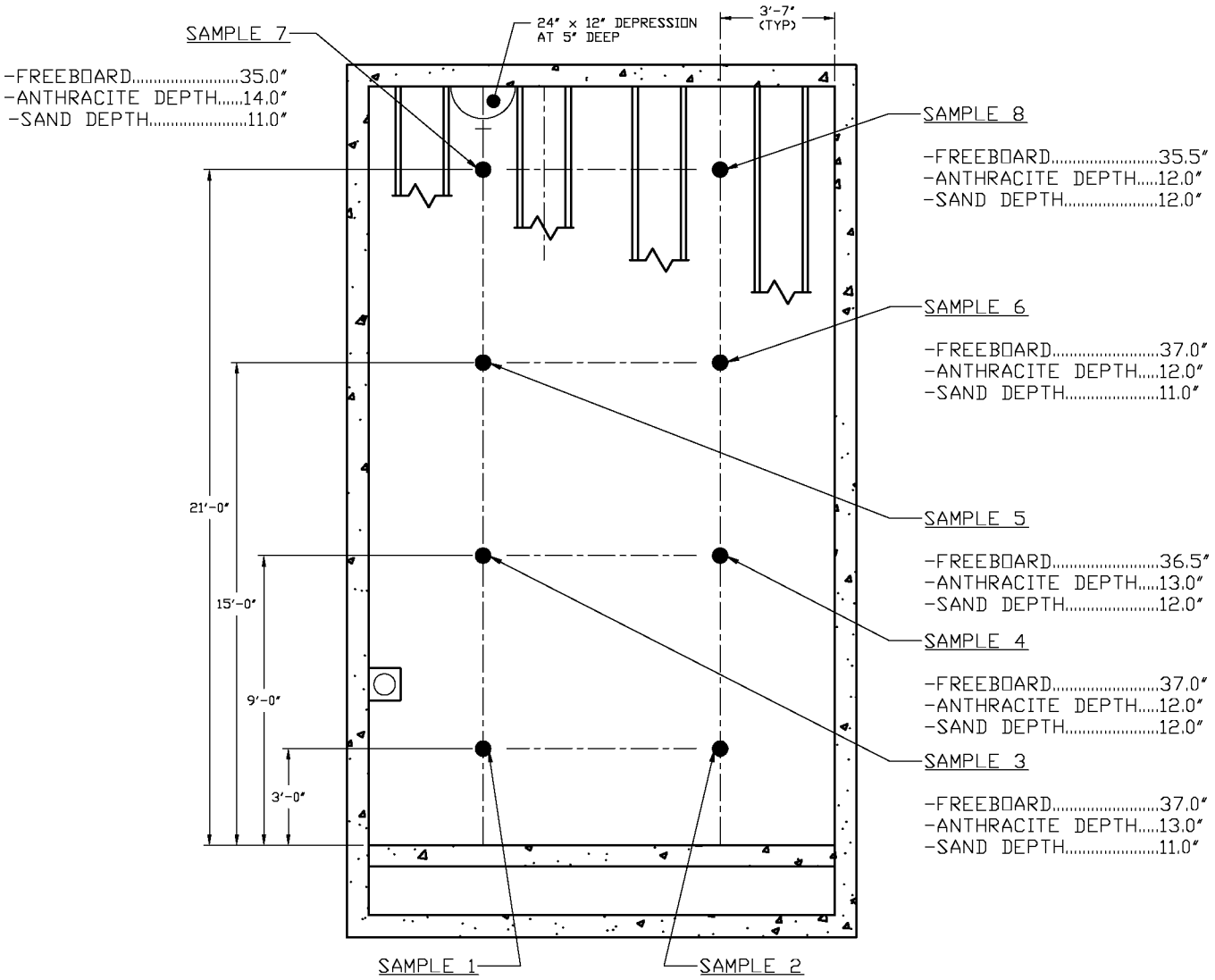
DRAWN	DATE	CHECKED BY	DATE
RCM	1/24/14		

NO.	REVISION	DATE	BY

SCALE	CONTRACT	SECTION: B	DWG. NO.
0-3/16" = 1'-0"	4046-S		

ROBERTS WATER TECHNOLOGIES, INC.

DARBY, PENNSYLVANIA 19023



FILTER 8

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DRAWN	DATE	CHECKED BY	DATE
RCM	1/24/14		

NO.	REVISION	DATE	BY

SCALE	CONTRACT	SECTION: B	DWG. NO.
0-3/16" = 1'-0"	4046-S		

Roberts Services, Inc.
SERVING THE WATER COMMUNITY

214 N. Jackson Street
Media, PA 19063
www.robertsfilter.com
610-583-3131
Fax 610-583-0117

Appendix 2

- Bowser-Morner, Inc. Laboratory Report

BOWSER-MORNER, INC.

Delivery Address: 4518 Taylorsville Road • Dayton, Ohio 45424 **Mailing Address**: P. O. Box 51 • Dayton, Ohio 45401

AASHTO/ISO 17025 Accredited • USACE Validated

LABORATORY REPORT

Report To: Roberts Water Technologies
Attn: Loretta Dombalagian
P.O. Box 167
Darby, PA 19023

Report Date: February 26, 2014
Job No.: 165129
Report No.: 711779
No. of Pages: 19

Report On: Laboratory Analysis of Sixteen Filter Media Samples
Project: New Brunswick
PO Number: 0022705

On February 14, 2014, sixteen filter media samples were submitted for laboratory analysis. Testing was performed as specified by the client and in accordance with AWWA B100-09, "Standard for Filtering Material".

Results are presented on the attached data sheets.

Should you have any questions, or if we may be of further service, please contact me at (937) 236-8805, extension 329.

Respectfully submitted,
BOWSER-MORNER, INC.

Scott D. Ruhlkamp, Supervisor
Special Projects Sections
Construction Materials Laboratory

SDR/llg
711779
1-File
1-ldombalagian@robertsfilter.com

All Reports Remain The Confidential Property Of BOWSER-MORNER And No Publication Or Distribution Of Reports May Be Made Without Our Express Written Consent, Except As Authorized By Contract. Results Contained In This Report Are Reflective Only of The Items Calibrated or Tested. Unless Otherwise Agreed, Samples Or Specimens Will Be Discarded Or Returned At Bowser-Morner's Discretion. AASHTO/ISO 17025 Accreditation applies only to the parameters included in BOWSER-MORNER'S current scope of accreditation. Go to www.bowser-morner.com/accreditations for review.

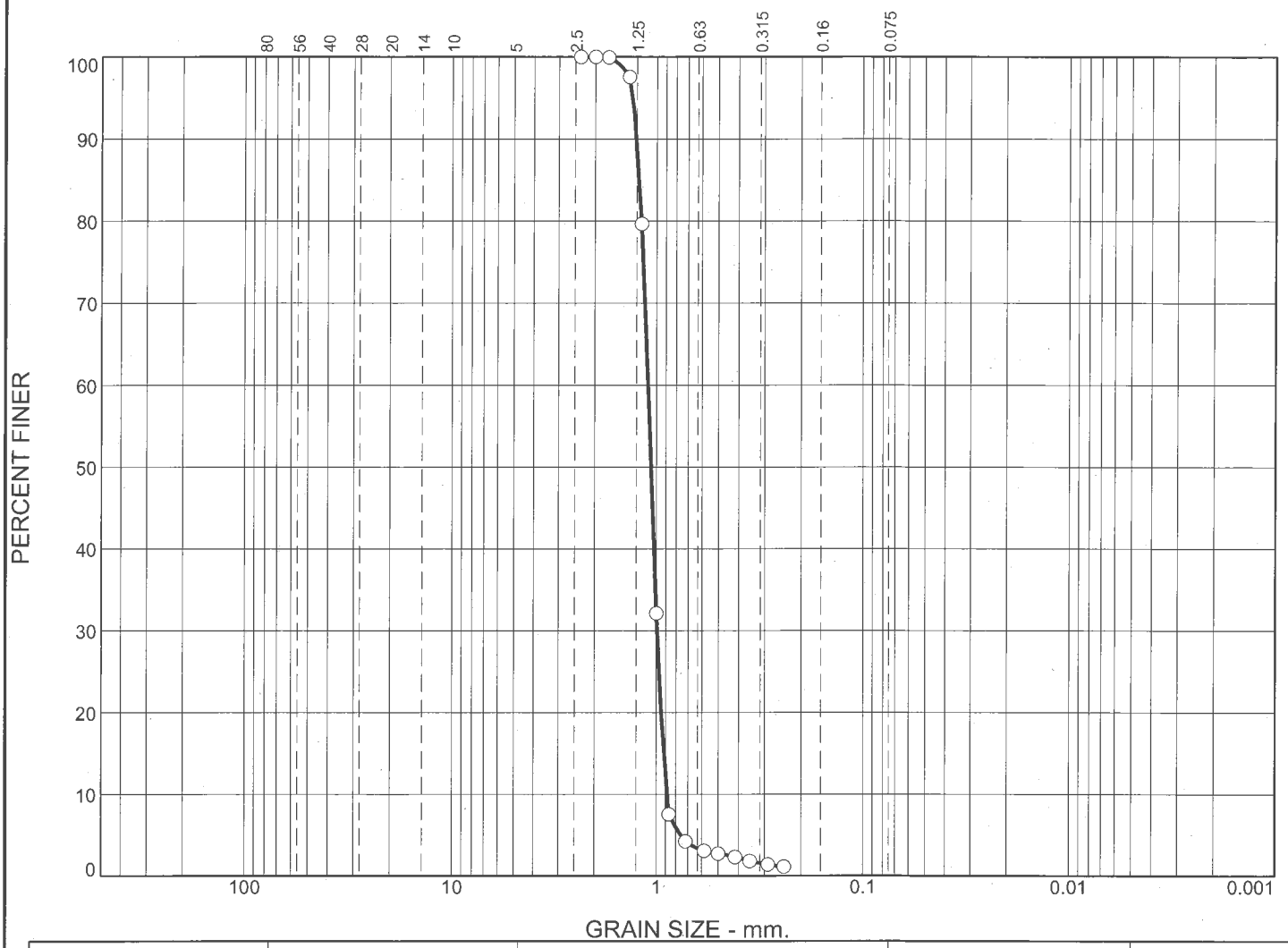
Anthracite

Sieve Size										
USA Standard	Nominal mm	Effective mm	Filter #1	Filter #2	Filter #3	Filter #4	Filter #5	Filter #6	Filter #7	Filter #8
#8	2.36	2.36		100.0		100.0		100.0		100.0
#10	2.00	2.002	100.0	99.7	100.0	99.9	100.0	99.3	100.0	99.5
#12	1.70	1.721	99.9	97.9	99.8	98.9	99.8	95.9	99.7	95.9
#14	1.40	1.363	97.6	87.2	96.1	91.4	67.4	84.6	95.1	83.8
#16	1.18	1.183	79.7	58.4	72.1	66.8	30.2	61.7	72.9	60.9
#18	1.00	0.999	32.1	25.4	34.1	29.4	12.2	29.7	32.1	29.8
#20	0.850	0.868	7.5	9.0	12.6	9.8	8.5	14.1	9.8	13.4
#25	0.710	0.721	4.2	5.3	8.4	6.6	6.8	11.0	6.5	10.1
#30	0.600	0.586	3.1	4.1	6.6	5.4	5.5	8.3	5.6	8.2
#35	0.500	0.501	2.7	3.6	5.5	4.4	3.4	6.5	4.5	6.5
#40	0.425	0.415	2.3	2.8	3.9	3.0	2.0	5.0	2.8	4.5
#45	0.355	0.353	1.8	2.2	2.3	1.8	1.4	4.1	1.9	3.3
#50	0.300	0.289	1.4	1.7	1.6	1.2	1.2	3.6	1.6	2.8
#60	0.250	0.241	1.1	1.5	1.4	1.0	1.0	3.2	1.4	2.6
Effective Size, mm:			0.89	0.88	0.78	0.87	0.94	0.65	0.87	0.70
Uniformity Coefficient:			1.2	1.4	1.4	1.3	1.4	1.8	1.3	1.7

Sand

Sieve Size										
USA Standard	Nominal mm	Effective mm	Filter #1	Filter #2	Filter #3	Filter #4	Filter #5	Filter #6	Filter #7	Filter #8
#16	1.18	1.213	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
#18	1.00	1.007	**99.9**	**99.8**	**99.7**	**99.9**	**99.9**	**99.9**	**99.7**	**99.8**
#20	0.850	0.873	**98.1**	**97.6**	**97.2**	**98.8**	**98.4**	**97.8**	**97.8**	**98.2**
#25	0.710	0.705	**69.4**	**76.8**	**75.5**	**83.6**	**84.3**	**82.9**	**81.8**	**86.1**
#30	0.600	0.610	**21.9**	**31.1**	**32.4**	**39.3**	**46.4**	**38.8**	**40.3**	**47.9**
#35	0.500	0.504	**2.6**	**4.0**	**5.6**	**8.0**	**9.9**	**5.5**	**9.0**	**10.8**
#40	0.425	0.409	**0.2**	**0.6**	**0.8**	**1.6**	**1.2**	**0.9**	**1.1**	**2.1**
#45	0.355	0.348	**0.1**	**0.2**	**0.3**	**0.6**	**0.2**	**0.4**	**0.3**	**0.6**
#50	0.300	0.296			**0.3**	**0.3**	**0.1**			**0.3**
#60	0.250	0.249				**0.2**				
Effective Size, mm:			**0.57**	**0.54**	**0.54**	**0.52**	**0.50**	**0.53**	**0.51**	**0.50**
Uniformity Coefficient:			**1.2**	**1.2**	**1.3**	**1.3**	**1.3**	**1.2**	**1.3**	**1.3**

Particle Size Distribution Report



	% +3"	% Gravel	% Sand	% Silt	% Clay
○	0.0	0.0			

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			1.2150	1.0990	1.0631	0.9907	0.9213	0.8890	1.00	1.24

	Material Description	USCS	AASHTO
○	Anthracite - Filter #1		

Project No. 165129 **Client:** Roberts Water Technologies

Project: New Brunswick

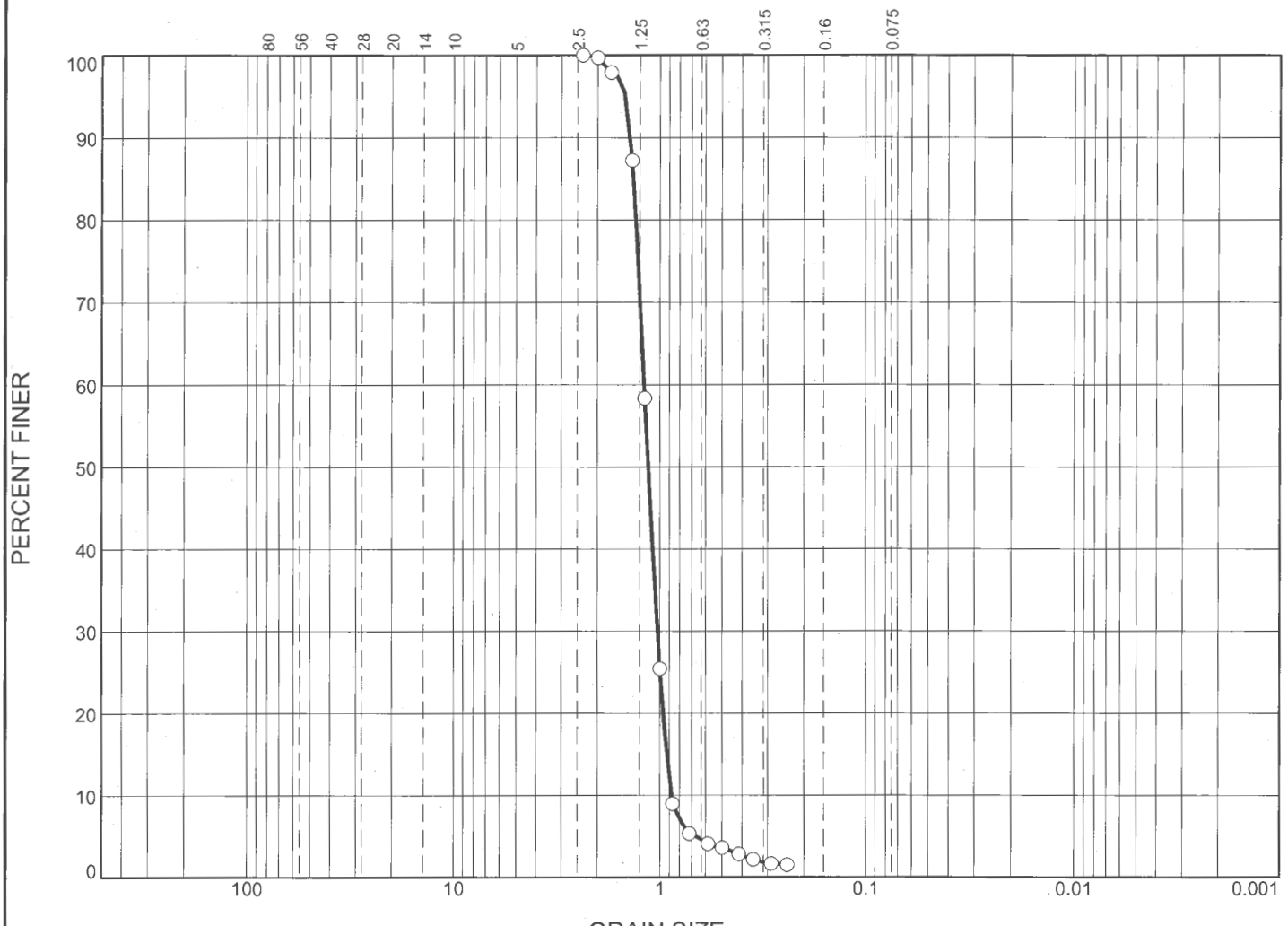
○ **Location:** Date Received: 2-14-14

Remarks:

BOWSER-MORNER, INC.

Dayton, Ohio

Particle Size Distribution Report



	% +3"	% Gravel	% Sand	% Silt	% Clay
○	0.0	0.0			

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			1.3436	1.1917	1.1386	1.0269	0.9267	0.8804	1.01	1.35

Material Description	USCS	AASHTO
○ Anthracite - Filter #2		

Project No. 165129 **Client:** Roberts Water Technologies

Project: New Brunswick

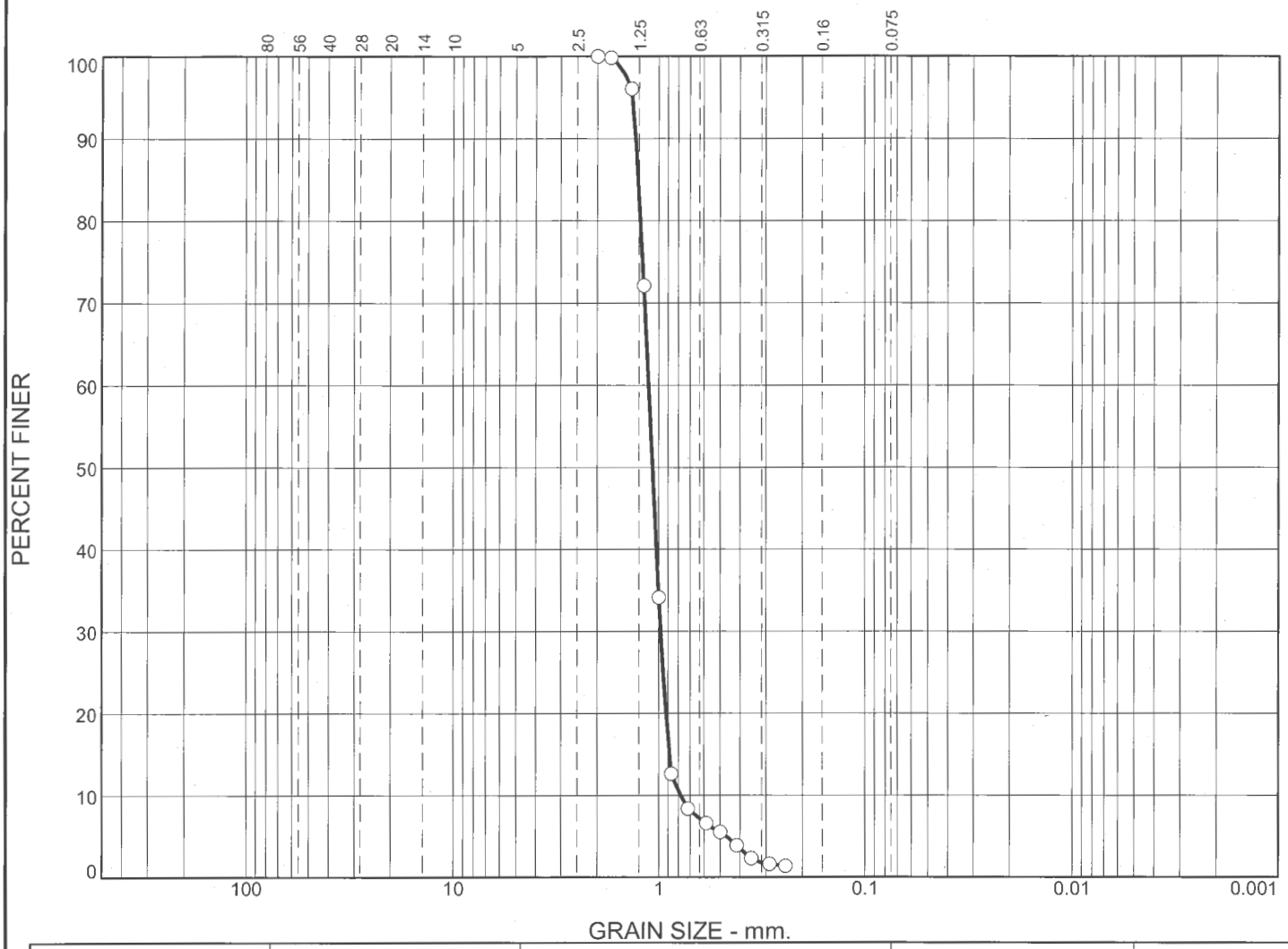
○ **Location:** Date Received: 2-14-14

Remarks:

BOWSER-MORNER, INC.

Dayton, Ohio

Particle Size Distribution Report



	% +3"	% Gravel	% Sand	% Silt	% Clay
○	0.0	0.0			

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			1.2616	1.1210	1.0736	0.9784	0.8888	0.7840	1.09	1.43

Material Description	USCS	AASHTO
○ Anthracite - Filter #3		

Project No. 165129 **Client:** Roberts Water Technologies

Project: New Brunswick

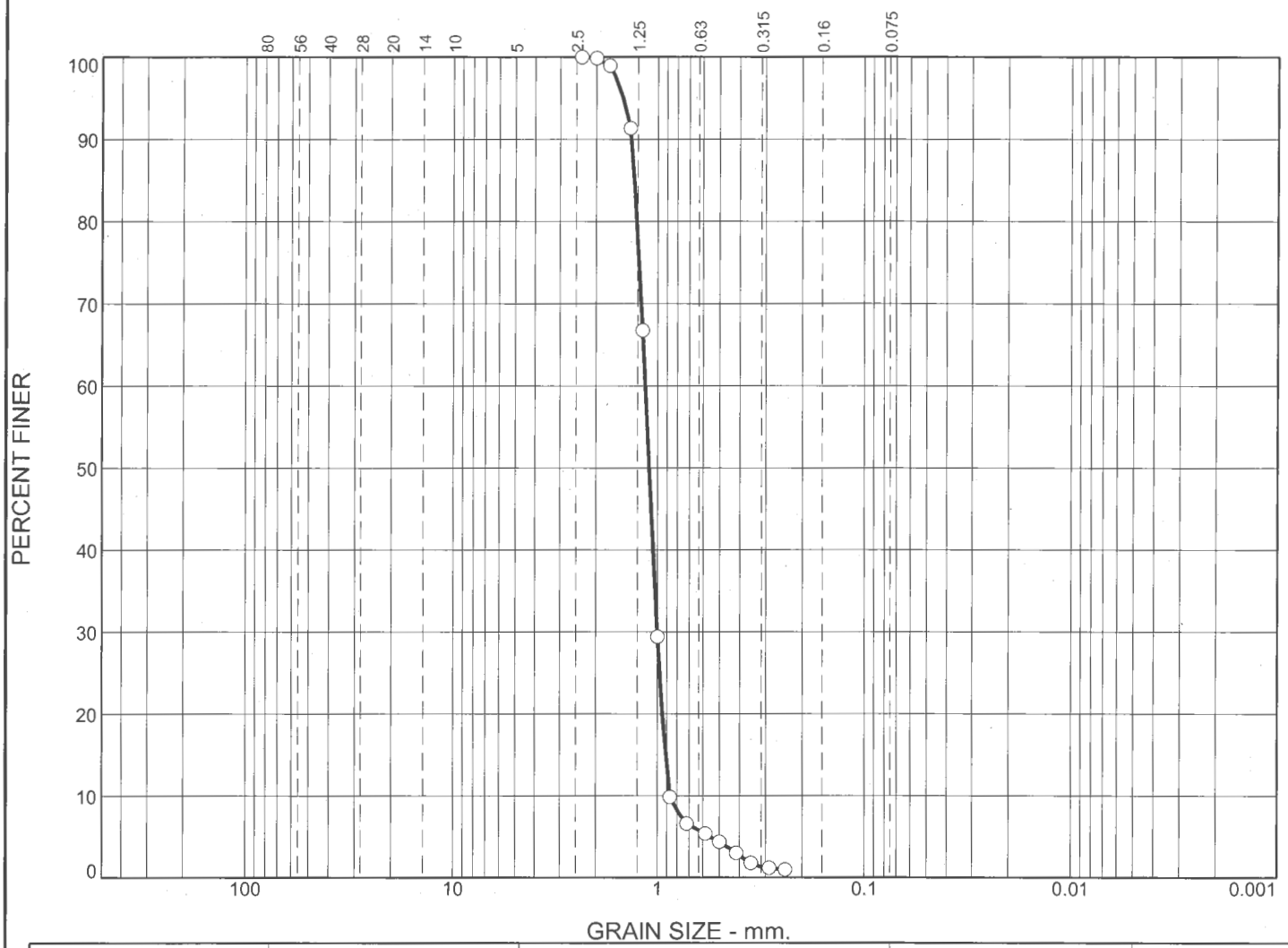
○ **Location:** Date Received: 2-14-14

Remarks:

BOWSER-MORNER, INC.

Dayton, Ohio

Particle Size Distribution Report



	% +3"	% Gravel	% Sand	% Silt	% Clay
○	0.0	0.0			

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			1.3008	1.1476	1.0986	1.0021	0.9136	0.8697	1.01	1.32

	Material Description	USCS	AASHTO
○	Anthracite - Filter #4		

Project No. 165129 **Client:** Roberts Water Technologies

Project: New Brunswick

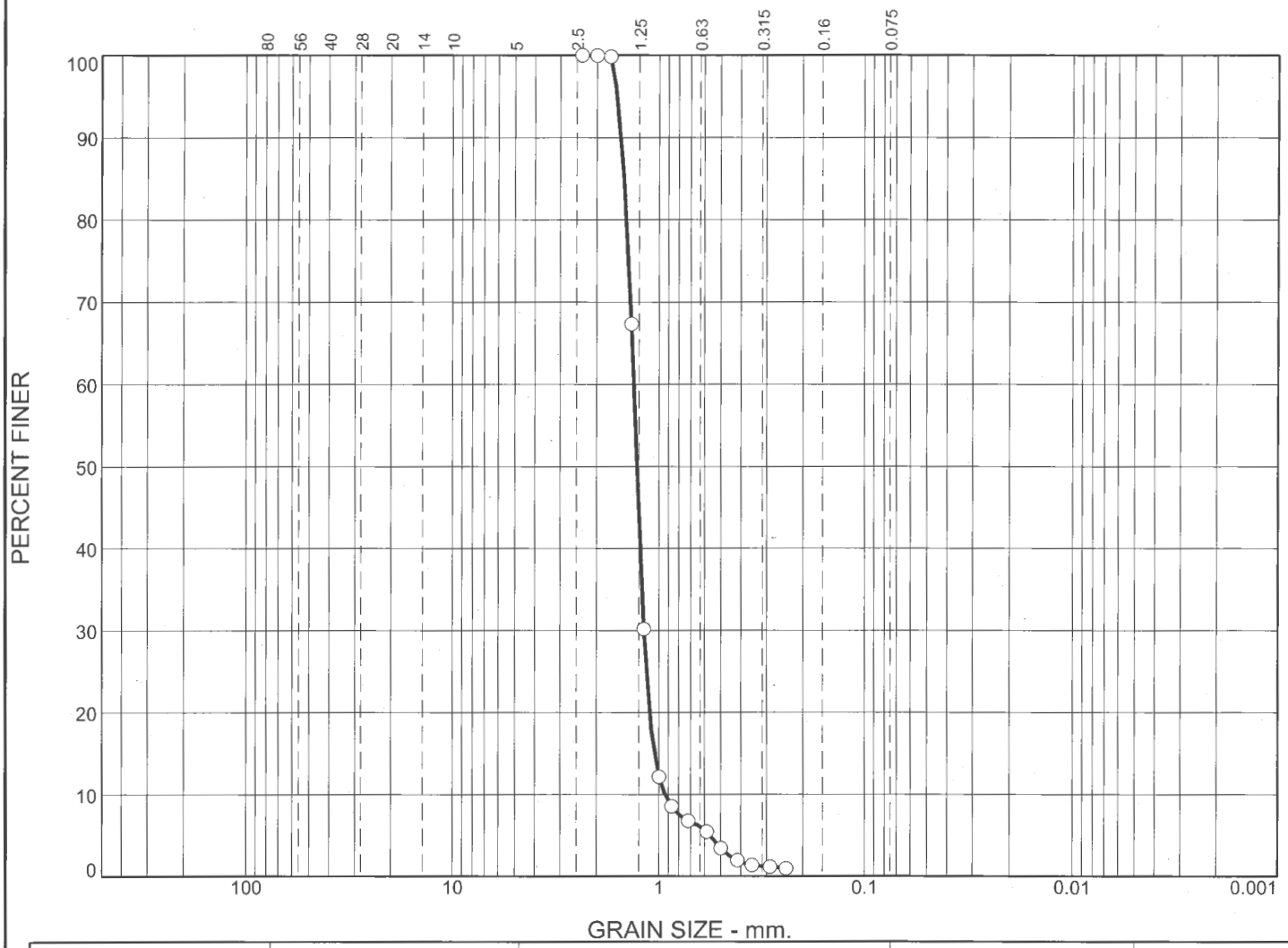
○ **Location:** Date Received: 2-14-14

Remarks:

BOWSER-MORNER, INC.

Dayton, Ohio

Particle Size Distribution Report



	% +3"	% Gravel	% Sand	% Silt	% Clay
○	0.0	0.0			

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			1.4833	1.3256	1.2789	1.1819	1.0527	0.9360	1.13	1.42

Material Description	USCS	AASHTO
○ Anthracite - Filter #5		

Project No. 165129 **Client:** Roberts Water Technologies

Project: New Brunswick

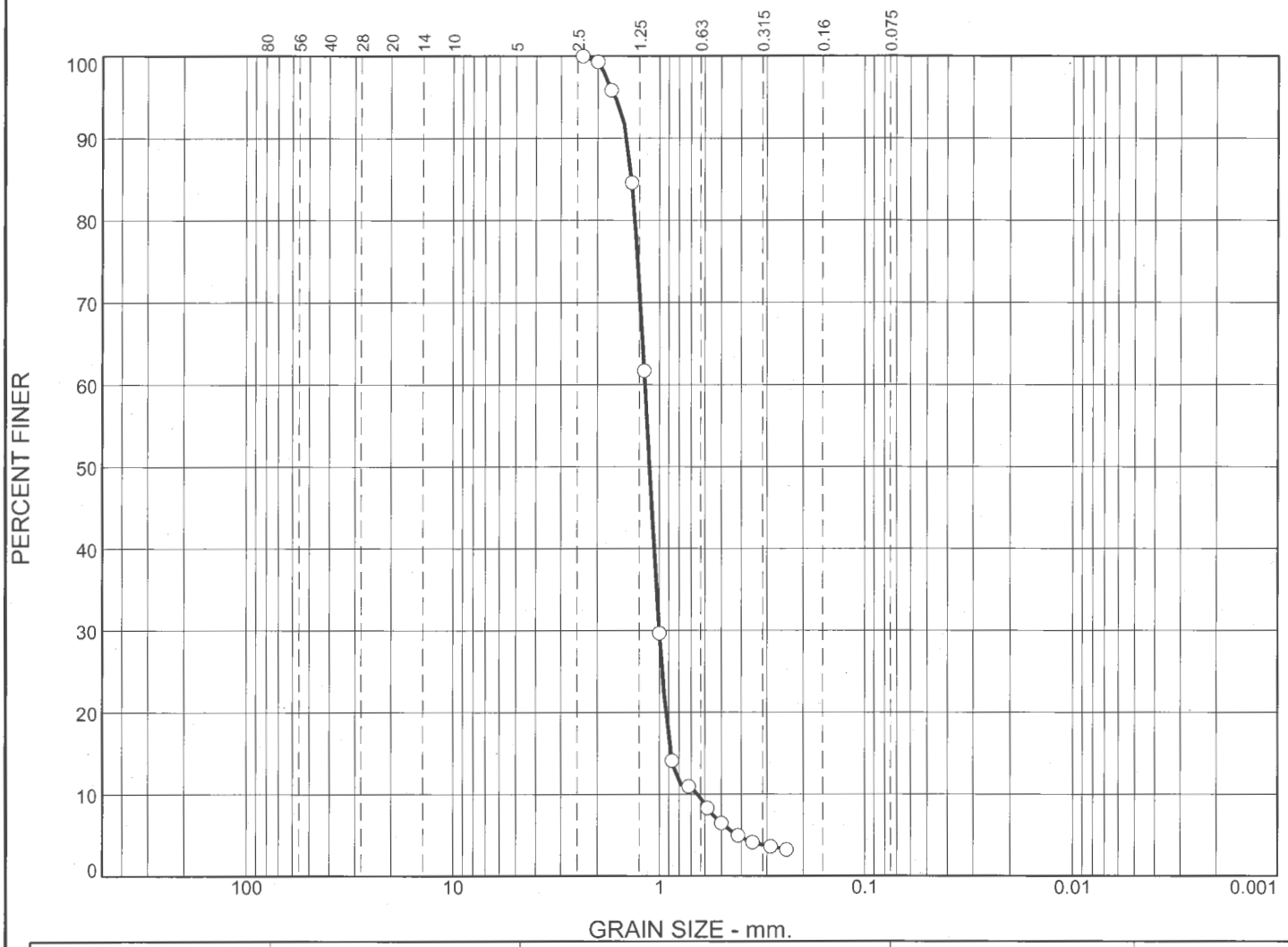
○ **Location:** Date Received: 2-14-14

Remarks:

BOWSER-MORNER, INC.

Dayton, Ohio

Particle Size Distribution Report



	% +3"	% Gravel	% Sand	% Silt	% Clay
○	0.0	0.0			

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			1.3676	1.1727	1.1151	1.0009	0.8801	0.6519	1.31	1.80

	Material Description	USCS	AASHTO
○	Anthracite - Filter #6		

Project No. 165129 **Client:** Roberts Water Technologies

Project: New Brunswick

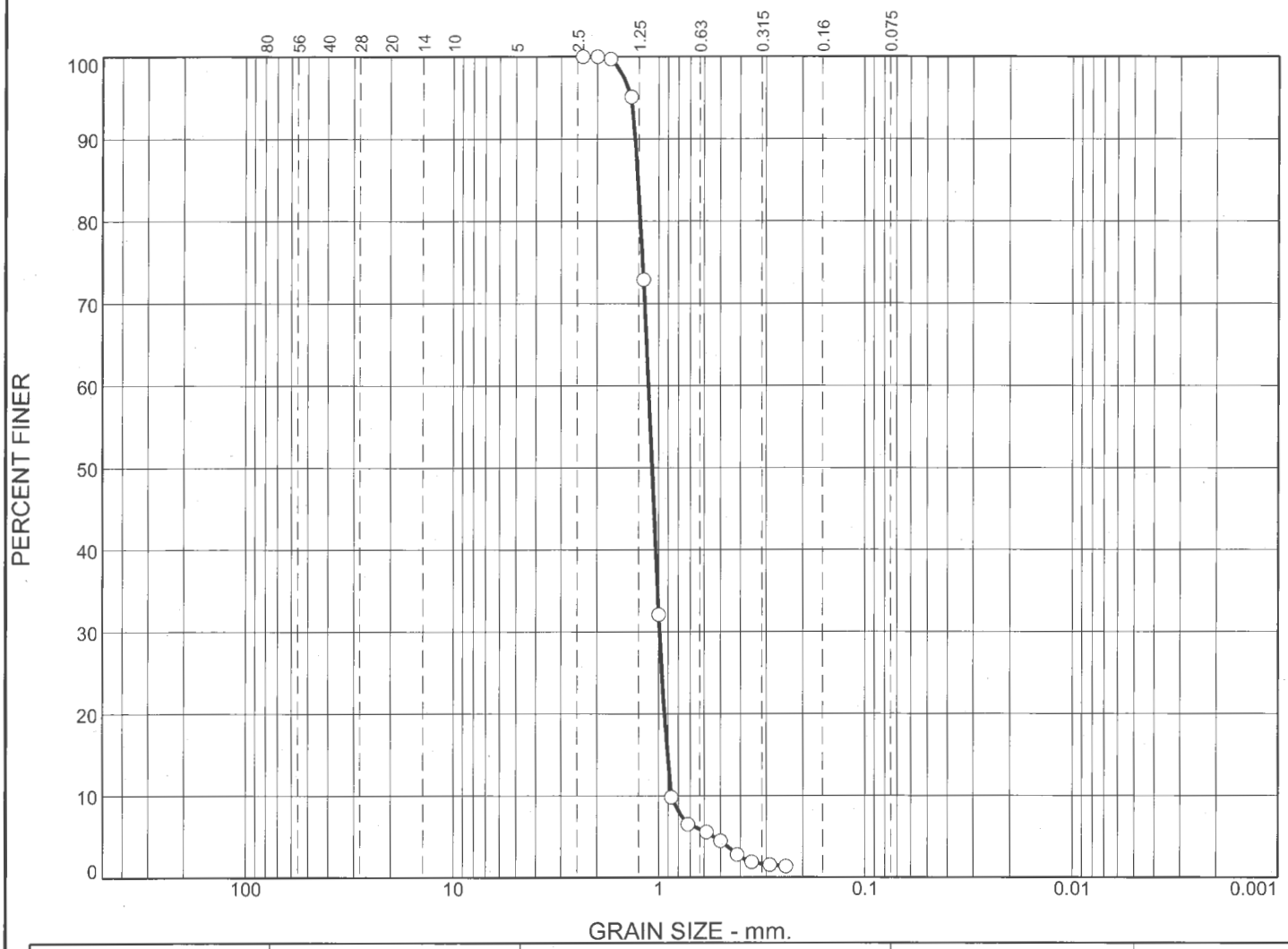
○ **Location:** Date Received: 2-14-14

Remarks:

BOWSER-MORNER, INC.

Dayton, Ohio

Particle Size Distribution Report



	% +3"	% Gravel	% Sand	% Silt	% Clay
○	0.0	0.0			

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_C	C_u
○			1.2600	1.1198	1.0760	0.9894	0.9093	0.8700	1.00	1.29

	Material Description	USCS	AASHTO
○	Anthracite - Filter #7		

Project No. 165129 **Client:** Roberts Water Technologies

Project: New Brunswick

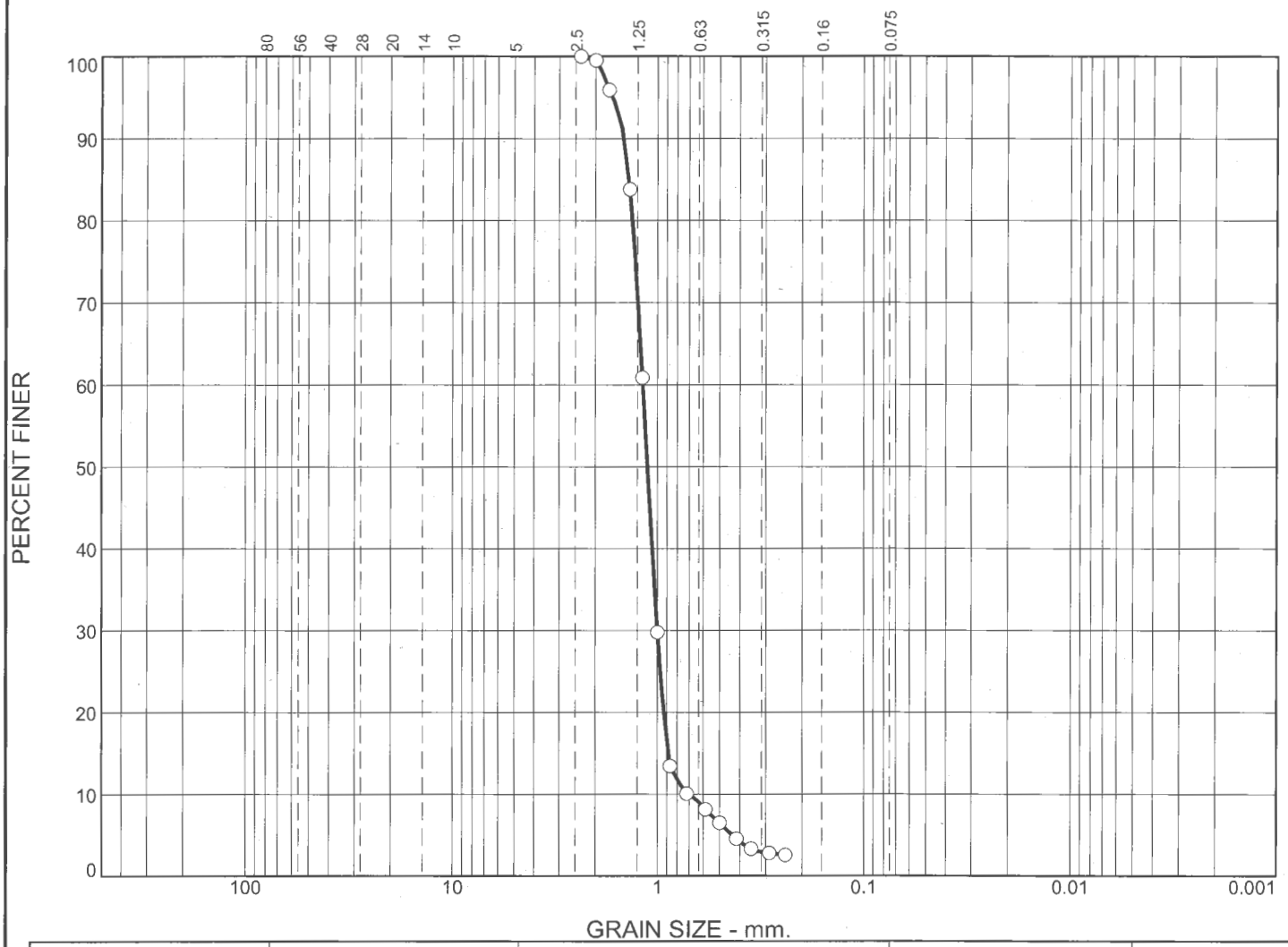
○ **Location:** Date Received: 2-14-14

Remarks:

BOWSER-MORNER, INC.

Dayton, Ohio

Particle Size Distribution Report



	% +3"	% Gravel	% Sand	% Silt	% Clay
○	0.0	0.0			

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			1.3773	1.1776	1.1178	1.0003	0.8865	0.7030	1.21	1.68

Material Description	USCS	AASHTO
○ Anthracite - Filter #8		

Project No. 165129 **Client:** Roberts Water Technologies

Project: New Brunswick

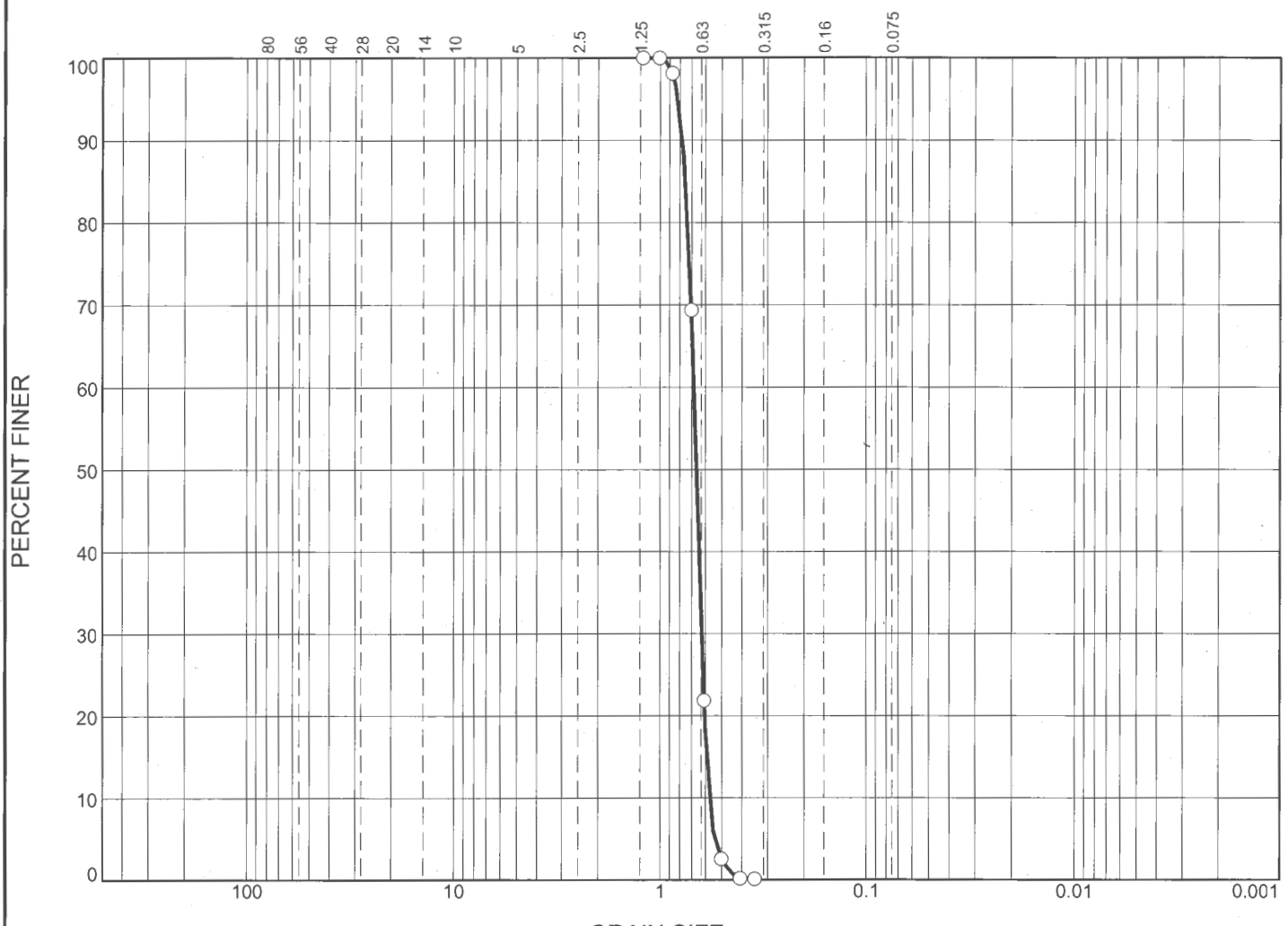
○ **Location:** Date Received: 2-14-14

Remarks:

BOWSER-MORNER, INC.

Dayton, Ohio

Particle Size Distribution Report



	% +3"	% Gravel	% Sand	% Silt	% Clay
○	0.0	0.0			

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.7547	0.6844	0.6650	0.6274	0.5914	0.5731	1.00	1.19

	Material Description	USCS	AASHTO
○	Sand - Filter #1		

Project No. 165129 **Client:** Roberts Water Technologies

Project: New Brunswick

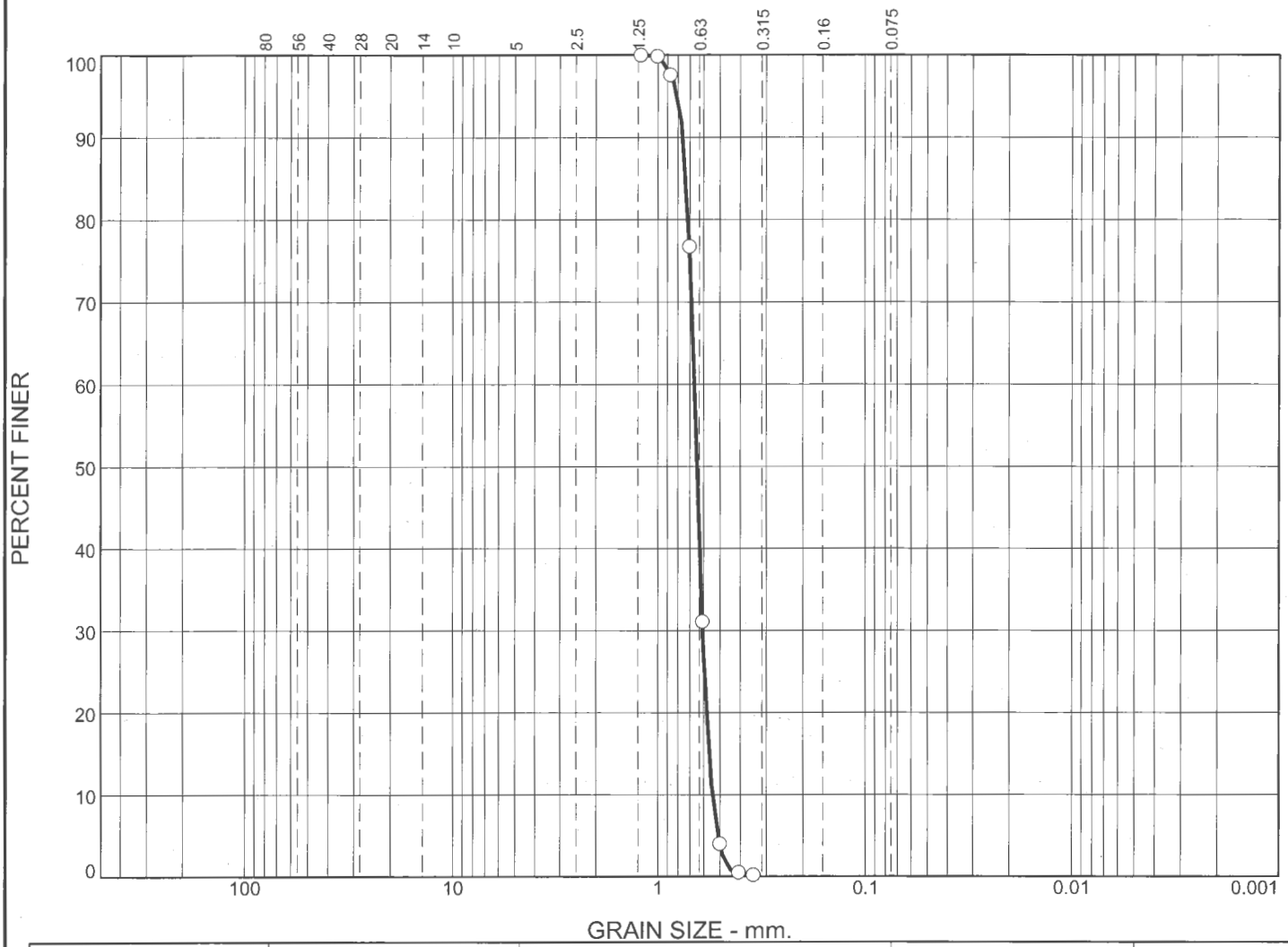
○ **Location:** Date Received: 2-14-14

Remarks:

BOWSER-MORNER, INC.

Dayton, Ohio

Particle Size Distribution Report



	% +3"	% Gravel	% Sand	% Silt	% Clay
○	0.0	0.0			

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.7326	0.6668	0.6474	0.6075	0.5656	0.5446	1.02	1.22

	Material Description	USCS	AASHTO
○	Sand - Filter #2		

Project No. 165129 **Client:** Roberts Water Technologies

Project: New Brunswick

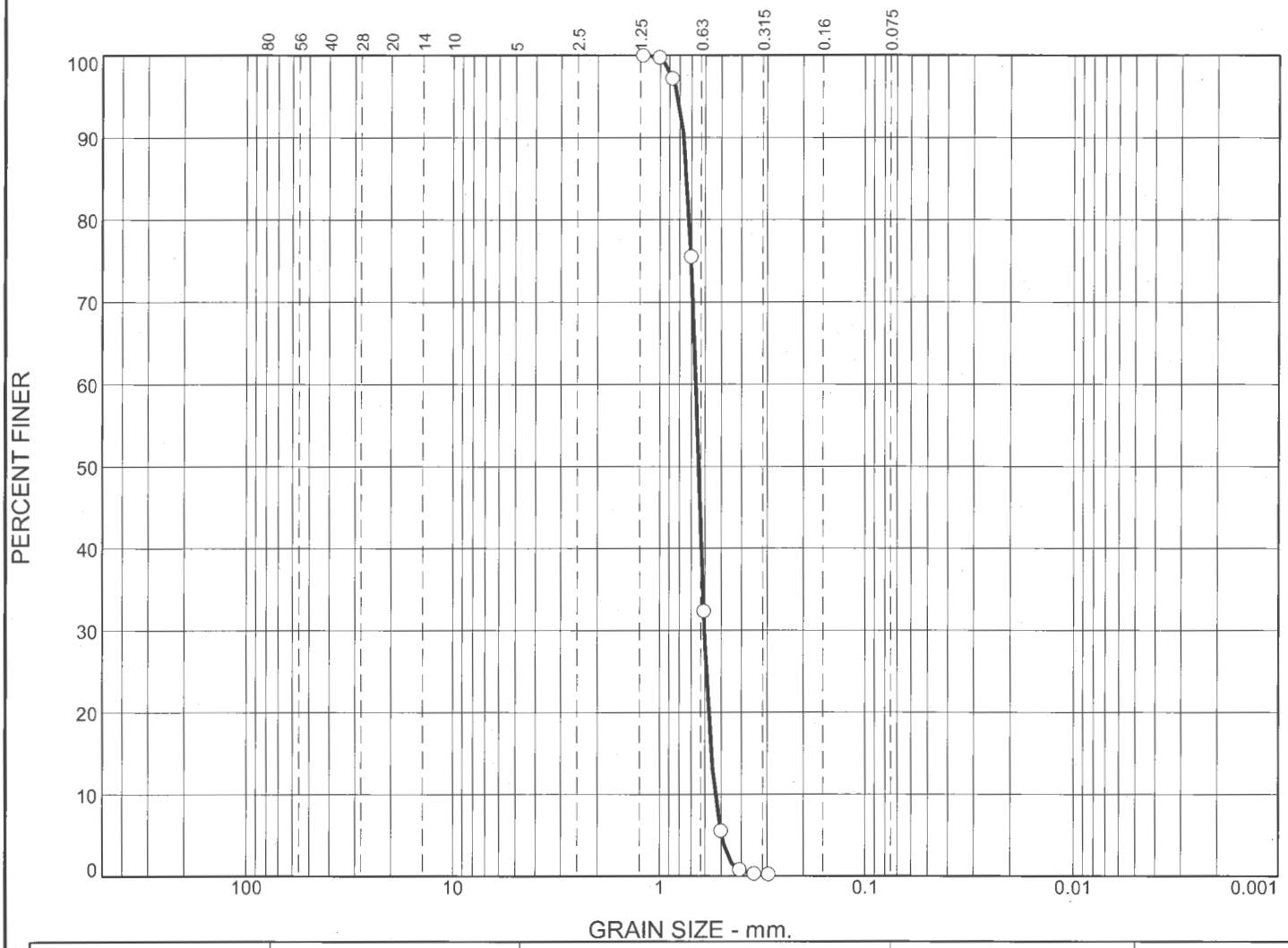
○ **Location:** Date Received: 2-14-14

Remarks:

BOWSER-MORNER, INC.

Dayton, Ohio

Particle Size Distribution Report



	% +3"	% Gravel	% Sand	% Silt	% Clay
○	0.0	0.0			

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.7389	0.6676	0.6470	0.6044	0.5585	0.5350	1.02	1.25

	Material Description	USCS	AASHTO
○	Sand - Filter #3		

Project No. 165129 **Client:** Roberts Water Technologies

Project: New Brunswick

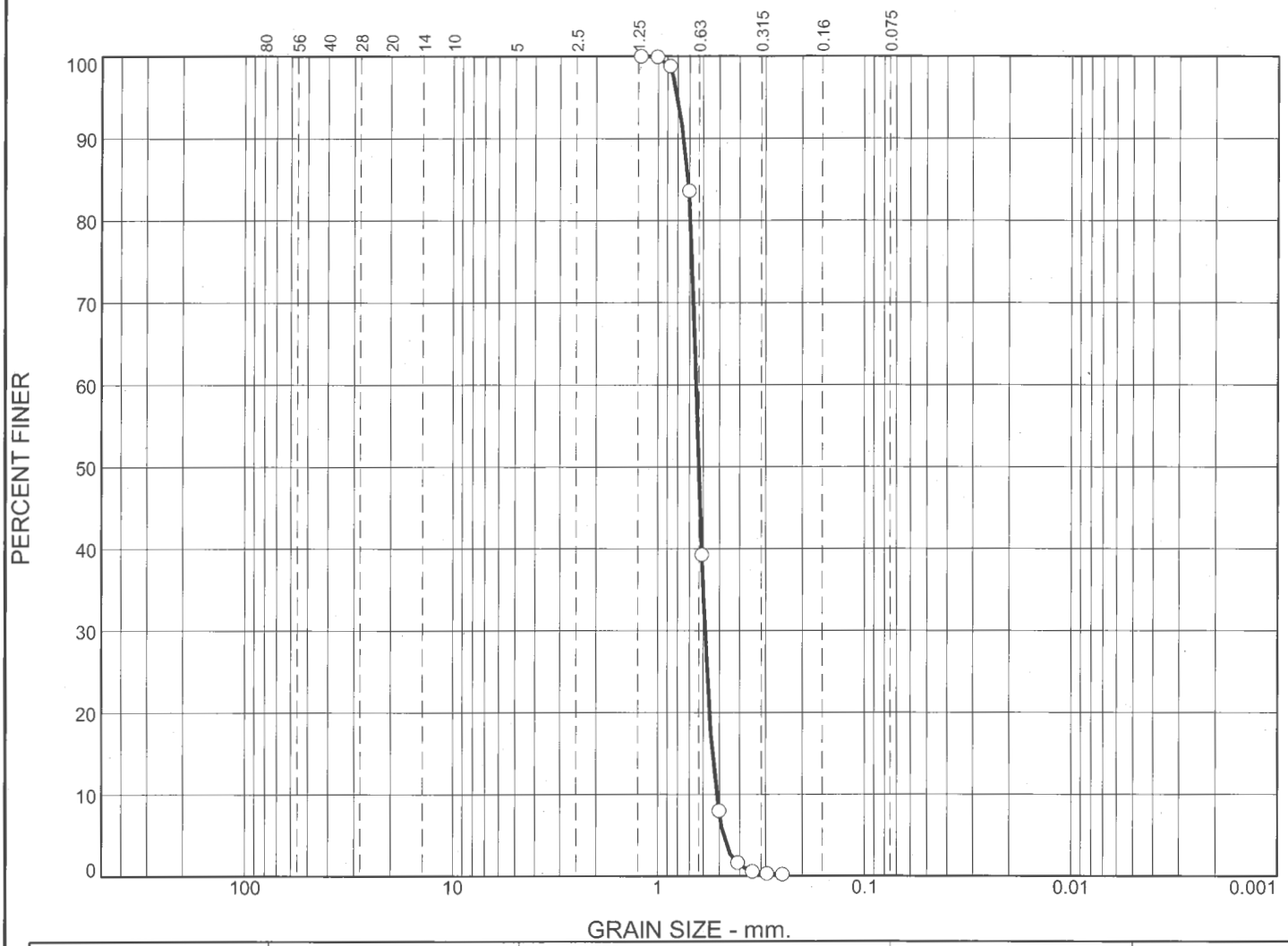
○ **Location:** Date Received: 2-14-14

Remarks:

BOWSER-MORNER, INC.

Dayton, Ohio

Particle Size Distribution Report



	% +3"	% Gravel	% Sand	% Silt	% Clay
○	0.0	0.0			

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.7141	0.6510	0.6316	0.5884	0.5407	0.5165	1.03	1.26

	Material Description	USCS	AASHTO
○	Sand Filter #4		

Project No. 165129 **Client:** Roberts Water Technologies

Project: New Brunswick

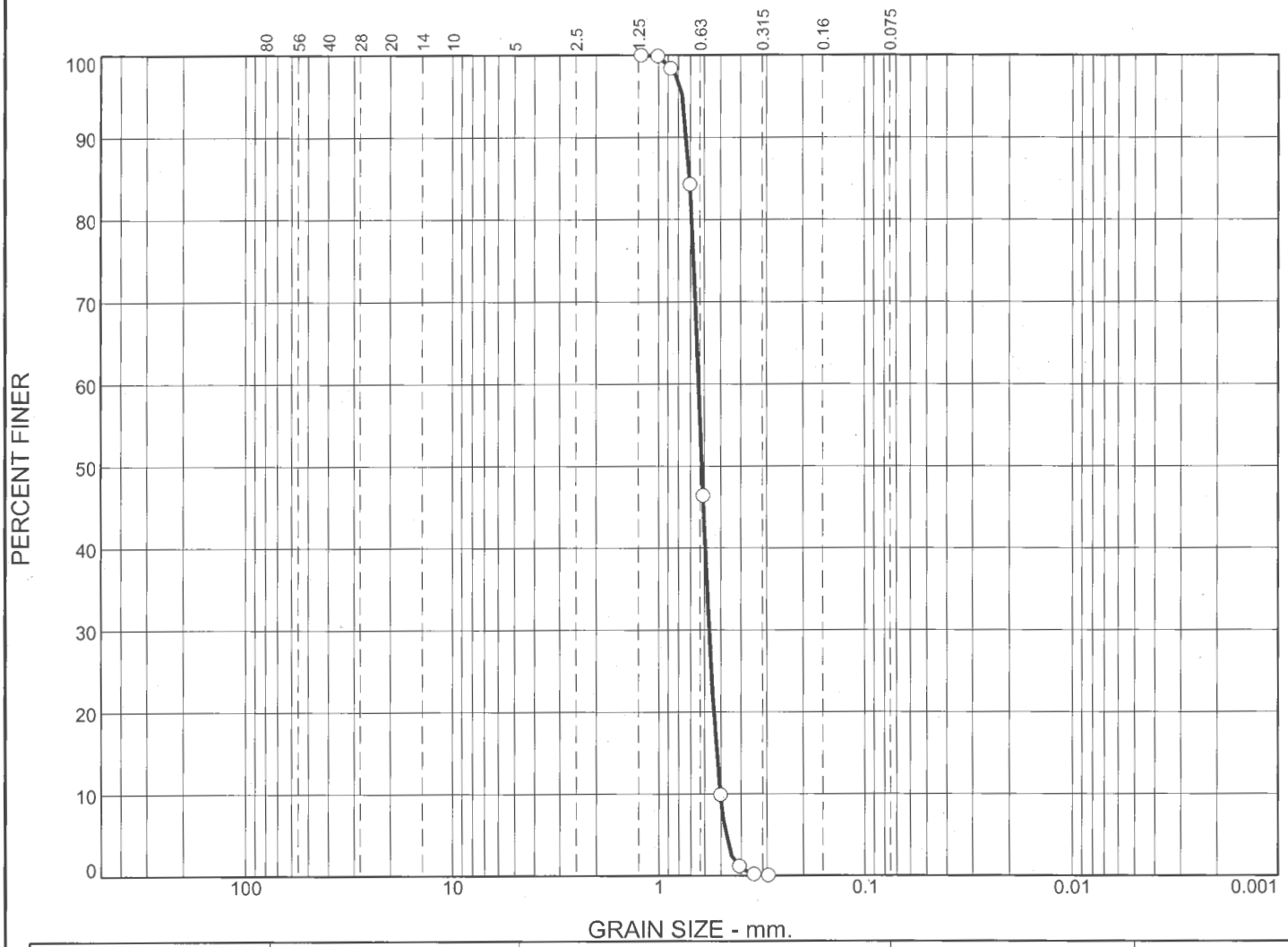
○ **Location:** Date Received: 2-14-14

Remarks:

BOWSER-MORNER, INC.

Dayton, Ohio

Particle Size Distribution Report



	% +3"	% Gravel	% Sand	% Silt	% Clay
○	0.0	0.0			

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.7076	0.6403	0.6180	0.5701	0.5247	0.5044	1.01	1.27

	Material Description	USCS	AASHTO
○	Sand - Filter #5		

Project No. 165129 **Client:** Roberts Water Technologies

Project: New Brunswick

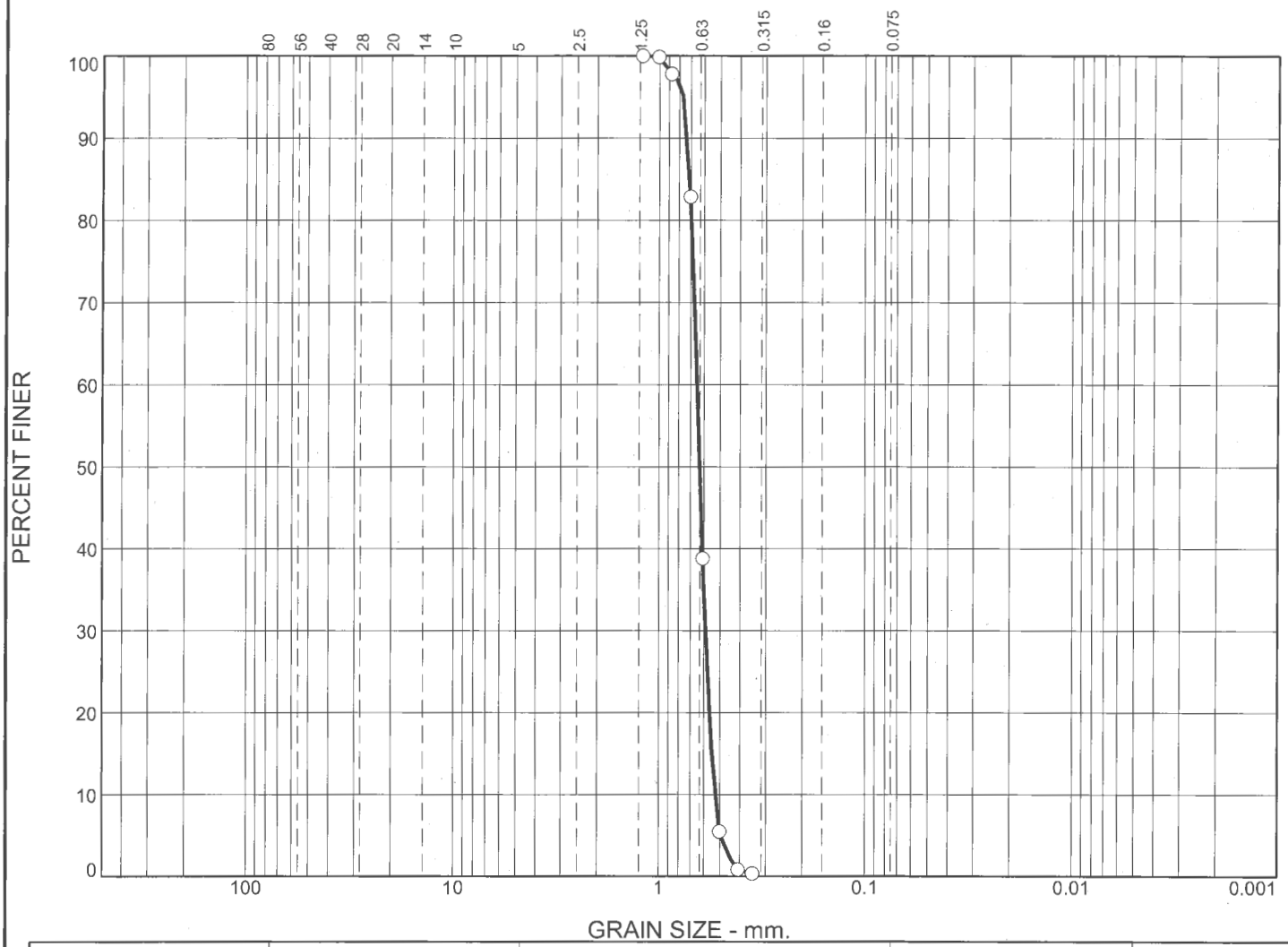
○ **Location:** Date Received: 2-14-14

Remarks:

BOWSER-MORNER, INC.

Dayton, Ohio

Particle Size Distribution Report



	% +3"	% Gravel	% Sand	% Silt	% Clay
○	0.0	0.0			

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.7120	0.6517	0.6323	0.5903	0.5476	0.5280	1.01	1.23

Material Description	USCS	AASHTO
○ Sand - Filter #6		

Project No. 165129 **Client:** Roberts Water Technologies

Project: New Brunswick

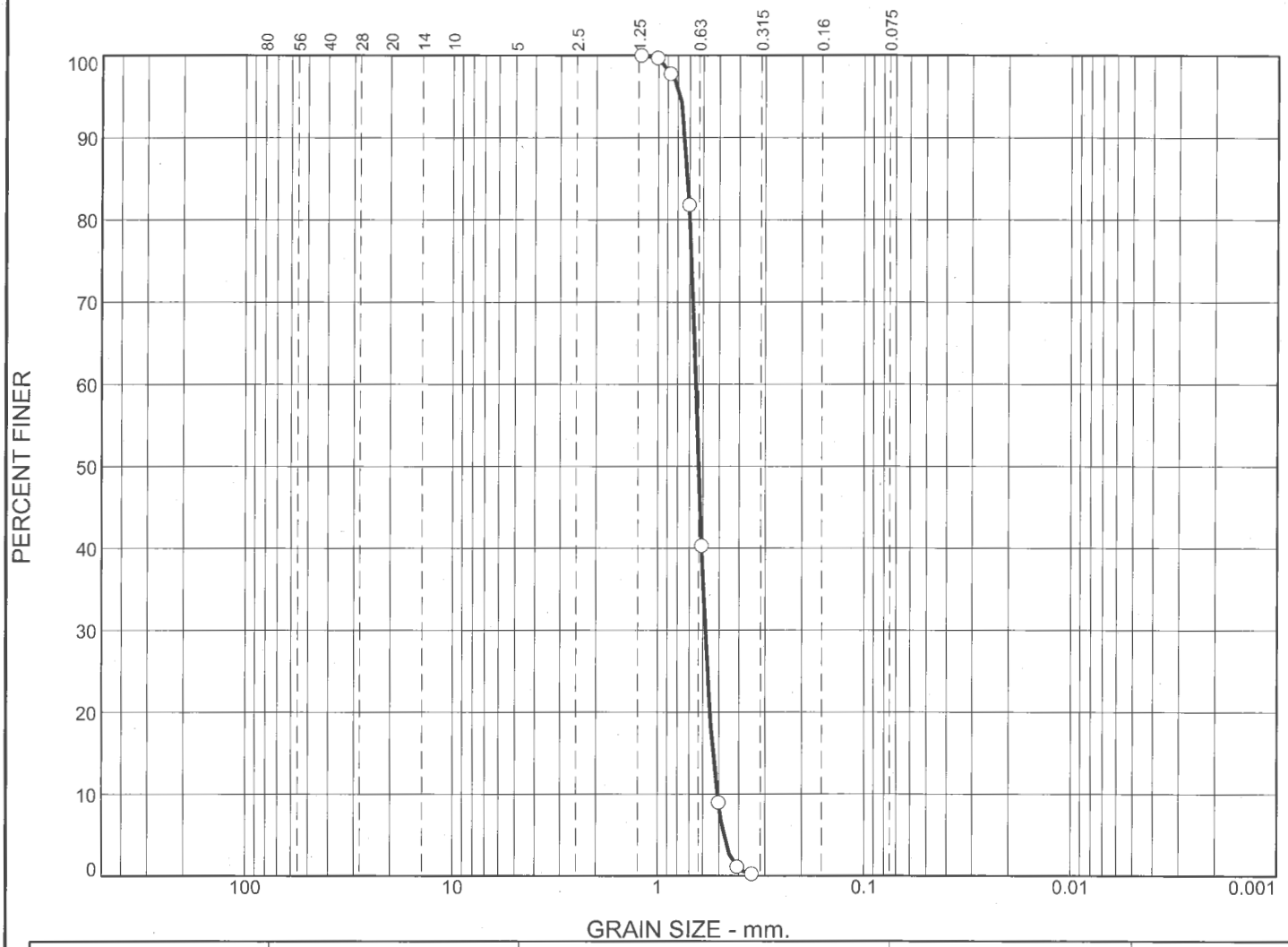
○ **Location:** Date Received: 2-14-14

Remarks:

BOWSER-MORNER, INC.

Dayton, Ohio

Particle Size Distribution Report



	% +3"	% Gravel	% Sand	% Silt	% Clay
○	0.0	0.0			

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.7161	0.6515	0.6307	0.5846	0.5345	0.5100	1.03	1.28

	Material Description	USCS	AASHTO
○	Sand - Filter #7		

Project No. 165129 **Client:** Roberts Water Technologies

Project: New Brunswick

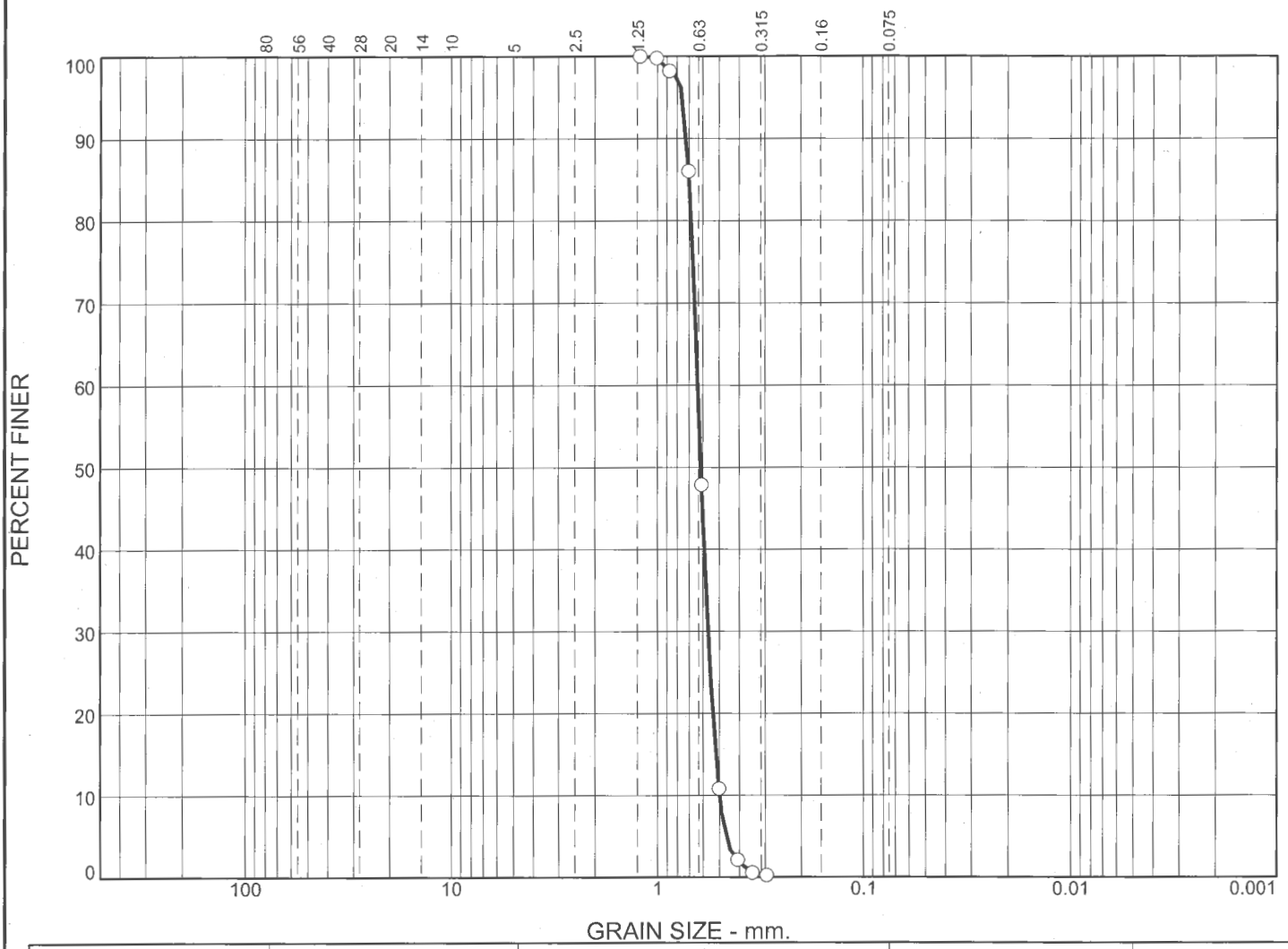
○ **Location:** Date Received: 2-14-14

Remarks:

BOWSER-MORNER, INC.

Dayton, Ohio

Particle Size Distribution Report



	% +3"	% Gravel	% Sand	% Silt	% Clay
○	0.0	0.0			

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.7011	0.6365	0.6147	0.5670	0.5212	0.5000	1.01	1.27

Material Description	USCS	AASHTO
○ Sand -Filter #8		

Project No. 165129 **Client:** Roberts Water Technologies

Project: New Brunswick

○ **Location:** Date Received: 2-14-14

Remarks:

BOWSER-MORNER, INC.

Dayton, Ohio

Roberts Services, Inc.
SERVING THE WATER COMMUNITY

214 N. Jackson Street
Media, PA 19063
www.robertsfilter.com
610-583-3131
Fax 610-583-0117

Appendix 3

- IMC Consulting: Microscopic Analysis Report and Pictures
- Red River Laboratory Certificate of Analysis

March 19, 2012

New Brunswick, PA
Roberts Filter Group
Att: Andy Taylor
214 N. Jackson Street
Media, PA 19063

Summary for Samples from Filter #2

Samples were provided from the aforementioned filters and analyzed by Red River Laboratories of Oklahoma City, OK. The two different samples from Filter #2 contained anthracite and sand/anthracite mix. The samples were visibly dirty after drying. The material is discolored due to Fe, Mn and organic build up. The DWL/Acid Solubility of the anthracite was high at 3.2%. The sand was as expected lower at 1.9%. The Mn content is very high at 6590 mg/kg and the Fe content is moderate to high at 643 mg/kg. The Fe content on the sand was still high at 446 mg/kg. Before and after acid washing sample tubes were provided. A sieve analysis was not performed by Red River at this time. It was done by another laboratory. The results need to be evaluated to confirm if the current material meets specifications.

Laboratory Results:

Filter #	Dry Weight Loss/ Acid Solubility %	Fe in mg/kg	Mn in mg/kg	Uniformity Coefficient	Effective Size
2 - Anthracite	3.2	643.90	6590	n/a*	n/a*
2 - Sand	1.9	446.20	1528	n/a*	n/a*

***Sieve analysis was performed by someone else.**

3109 SW 131st Street
Oklahoma City, OK 73170

Phone: 405/343-0237
Phone: 405/823-0967

Email:Natasha@IMCConsulting.org
EmailInfo@IMCConsulting.org

Filter # 2 – Microscopic Pictures - Anthracite



Anthracite from **#2** in current condition.

Deposit build-up is visible especially around the edges of the media particles.



Anthracite from **#2** after laboratory treatment.

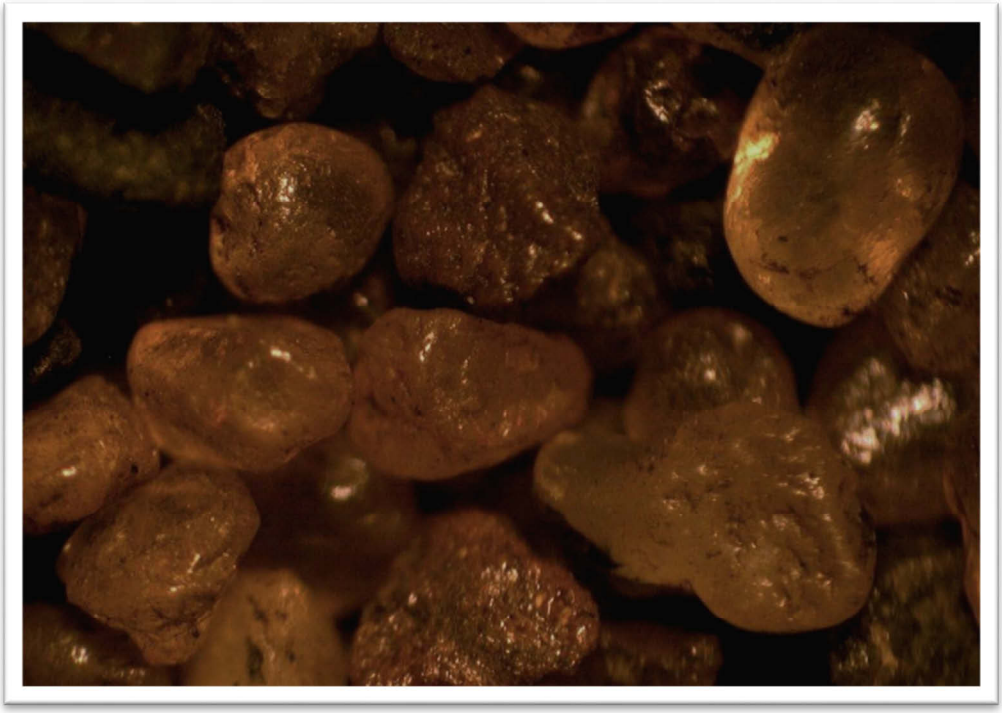
Deposit build-up is removed and the sharp edges of the media particles are visible.

3109 SW 131st Street
Oklahoma City, OK 73170

Phone: 405/343-0237
Phone: 405/823-0967

Email:Natasha@IMCConsulting.org
EmailInfo@IMCConsulting.org

Filter #2 – Microscopic Pictures – Sand



Sand from **#2** in current condition.

Deposit build-up is visible by heavy discoloration of the particles.

The sand is mixed with the anthracite.



Sand from **#2** after laboratory treatment.

The original color of the sand is visible after removal of the deposits.

The sand will re-stratify during backwashing of the filters.

3109 SW 131st Street
Oklahoma City, OK 73170

Phone: 405/343-0237
Phone: 405/823-0967

Email:Natasha@IMCConsulting.org
EmailInfo@IMCConsulting.org

Red River

Environmental Laboratory and Consulting Company

Analytical Laboratory - Environmental Consulting - Permit Application and Compliance

Certificate of Analysis

ODEQ ID # 9953

To: NEW BRUNSWICK
THE ROBERTS FILTER GROUP
214 N JACKSON
MEDIA, PA 19063

Project #:

Project Name:

Date Received: 1/31/2014

Report Date: 2/10/2014

Lab Number	Sample Identification	Date Sampled	Analysis Date	Analyzed Time	By	Parameter	Q	Results	Units	RL	SQL	Method	Batch
201400717	ANTHRACITE	1/27/2014	2/5/2014	12:00	SD	Dry Weight Loss		32,393	mg/kg				25652
		1/27/2014	2/7/2014	16:15	SD	Iron		643.9	mg/kg	0.009	0.09	EPA_6010	25650
		1/27/2014	2/7/2014	16:15	SD	Manganese		6590	mg/kg	0.001	0.5	EPA_6010	25651
201400718	SAND	1/27/2014	2/5/2014	12:00	SD	Dry Weight Loss		18,974	mg/kg				25652
		1/27/2014	2/7/2014	16:15	SD	Iron		446.2	mg/kg	0.009	0.09	EPA_6010	25650
		1/27/2014	2/7/2014	16:15	SD	Manganese		1528	mg/kg	0.001	0.5	EPA_6010	25651

Note:

RL = Reporting Limit. SQL* = Sample Quantitation Level.

B = Analyte was detected in both the sample and associated blank.

OL2 = Subcontracted to ODEQ Lab #7211.

M = Matrix effect present

BDL = Analyte was analyzed for but not detected above RL.

J = Analyte was detected above the RL but below the PQL.

Q = Surrogate recovery fell outside acceptance limits.

U = Analyte was analyed for but not detected above RL

* When a sample contains a high concentration of either a target or non-target compound(s) or interference, it must be diluted. SQL = Dilution factor x MDL. Samples are disposed of 20 days after the sample is reported.

Susie Southwell

Laboratory Authorized Signature

6510 S. Western Ave., Suite 207, Oklahoma City, OK 73139

Phone: (405)-232-1966 or 1-800-USA-KNOW Fax: 405-235-8234 www.RedRiverELCC.com