Supplemental Remedial Investigation and Interim Remedial Measures Work Plan

BCP Site #C915315
170 Jamison Road Site
Elma, New York

Revised October 2017 0400-017-001

Prepared For:

Moog Inc.

Prepared By:

TurnKey Environmental Restoration, LLC
Benchmark Environmental Engineering & Science, PLLC

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WORK PLAN
FOR
SUPPLEMENTAL REMEDIAL INVESTIGATION AND INTERIM REMEDIAL MEASURES

170 JAMISON ROAD SITE

ELMA, NEW YORK
BCP SITE NO. C915315

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SUPPLEMENTAL REMEDIAL INVESTIGATION AND INTERIM REMEDIAL MEASURES WORK PLAN

170 Jamison Road Site
Elma, New York

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1.0 INTRODUCTION

This document presents the proposed scope of work and implementation procedures for completion of a Supplemental Remedial Investigation (SRI) and Interim Remedial Measures (IRM) at the 170 Jamison Road Site (Site), located at 170 Jamison Road, Elma, New York (see Figures 1 and 2).

The Applicant, Moog Inc. (Moog) has elected to pursue cleanup and redevelopment of the Site under the New York State Brownfield Cleanup Program (BCP) and submitted a Brownfield Cleanup Program (BCP) application to the New York State Department of Environmental Conservation (NYSDEC) which was approved and a Brownfield Cleanup Agreement signed in June 2017 (BCP Site No. C915315).

The SRI/IRM will be completed by Benchmark Environmental Engineering & Science, PLLC (Benchmark) in association with TurnKey Environmental Restoration, LLC (TurnKey) on behalf of Moog. The work will be completed in accordance with NYSDEC DER-10 guidelines (Ref. 1).

1.1 Background

The Site, designated as 170 Jamison Road, consists of portions of five tax parcels, totaling approximately 4.06 acres, located in Elma, Erie County, New York. The Site is currently developed with two structures on-Site (Building 1 and 3) and one structure immediately adjacent to the site (Buildings 4). According to the Erie County Real Property & GIS Web page (http://www2.erie.gov/ecrpts/index.php?q=real-property-parcel-search) 170 Jamison Road, 170 Seneca Street and 0 Seneca Street are the addresses associated with the BCP Site.

The Site has historically been used for designing and supplying aircraft and missile components, has operated as a design, manufacture, and supply facility from 1951 to present, and is currently active. The property is zoned commercial and industrial. Moog's plans are to add on to existing Buildings 1 and 3 by constructing a 2 story addition consisting of a building footprint of nominally 45,950 square feet (sf).

A Remedial Investigation/Alternative Analysis (RI/AA) Work Plan was submitted to the NYSDEC and approved in June 2017. The RI field work was implemented in June and July 2017. Results of the RI, including soil, groundwater, stormwater and sub-slab vapor and indoor air sampling, were presented to the NYSDEC during a meeting in August 2017. On

the basis of this meeting and subsequent discussions with Moog and the NYSDEC, it was determined that supplemental storm water and groundwater sampling was required to more fully characterize the extent of contamination.

An Interim Remedial Measure (IRM) is planned to facilitate this redevelopment project; activities include soil, storm sewer pipe and sewer beddingscreening, segregation, characterization and off-site disposal of any encountered impacted materials, community air monitoring, and groundwater extraction, treatment and discharge to facilitate the new buildings construction (i.e. Buildings 1A and 3A).

As such, this work plan details the work for the SRI and the IRM.

1.2 Project Objectives

The primary objectives of the SRI/IRM are to:

- Install additional overburden and bedrock monitoring wells, and collect additional groundwater samples, under appropriate quality assurance/quality control criteria, to better delineate the extent of contamination;
- Collect additional stormwater samples, under appropriate quality assurance/quality control criteria, to better delineate the extent of contamination;
- Obtain additional data needed for the Alternative Analysis Report including: performance of the hydraulic conductivity testing of the uppermost-water bearing zone; and bench-scale groundwater treatability testing;
- Perform oversight of soil excavation, soil screening community air monitoring and groundwater pre-treatment ; and,
- Perform communication testing in Buildings 1 and 3 to support design-build installation of an ASD system in each of these buildings.

As part of the SRI/IRM sampling data will be used to evaluate whether groundwater remedial alternatives can meet the objectives. The intended uses of these data dictate the confidence levels. Two (2) data confidence levels will be employed in the SRI: screening level data and definitive level data. In general, screening level confidence will apply to field measurements, including photoionization detector (PID) measurements, groundwater elevation measurements, and field analyses (i.e., pH, temperature, dissolved oxygen, specific conductivity, and turbidity). Definitive level confidence will apply to samples for chemical

analysis. The applicability of these levels of data will be further specified in the Quality Assurance Project Plan (QAPP) in Section 5.0. Sampling and analytical acceptance and performance criteria such as precision, accuracy, representativeness, comparability, completeness, and sensitivity, are defined in the QAPP.

The IRMs will be completed to immediately address known environmental impacts related to past use of the Site. An IRM will quickly mitigate risks to public health and the environment. IRM activities will include excavation of impacted soil and fills, if encountered, from within the planned building footprint to design grades, segregation of clean soil from fill or other deleterious substances based on field screening and observations, management of groundwater by pumping groundwater and accumulated precipitation in the excavation, treating the water by settlement, bag filters, and either activated carbon, with discharge of the post-treated water to the ground surface or discharge to an on-site storm sewer equipped with an in-line air stripper. Details of anticipated IRM activities are included in Section 3.0

1.3 Project Organization and Responsibilities

The Applicant, Moog, has applied to the New York State BCP as a participant per ECL§27-1405. Benchmark, in association with TurnKey, will manage the brownfield cleanup on behalf of the Applicant. The NYSDEC Division of Environmental Remediation (Region 9), in consultation with the New York State Department of Health (NYSDOH) shall monitor the remedial actions to verify that the work is performed in accordance with the Brownfield Cleanup Agreement, the approved SRI/IRM Work Plan, and NYSDEC DER-10 guidance.

Benchmark/TurnKey personnel, as well as subcontractors, for this project have not all been determined at this time. Once pricing is secured, subcontract agreements are in place, and a field schedule determined, resumes for the selected project team will be provided to the Department, if requested. TurnKey's Project Manager's résumé, however, were included in Appendix A of the RI Work Plan. The table below presents the planned project team.

Company	Role	Name	Contact Information
TurnKey/Benchmark	Project Manager	Mike Lesakowski	(716) 856-0635
TurnKey/Benchmark	Qualified Env. Prof.	Tom Forbes, P.E.	(716) 856-0635
Moog	Facility Contact	Meri Scappatura	(716) 687-4476
Test America	Analytical Testing	Brian Fischer	(716) 504-9835
Earth Dimensions	Drilling Services	Brian Bartron	(716) 655-1717
TBD	Excavation Services	TBD	TBD
Data Validation Services	DUSR	Judy Harry	518-251-4429

2.0 SITE DESCRIPTION AND RI FINDINGS SUMMARY

2.1 General Site Description

The Site is comprised of portions of five tax parcels totaling approximately 4.06 acres located at 170 Jamison Road in Elma, Erie County, New York. The Site is bound by additional Moog property and Jamison Road to the north with commercial and residential properties beyond, Moog property extending to the south and east, and Seneca Street to the west with commercial properties beyond (see Figure 2).

2.2 Site Topography and Drainage

The Site slopes towards the northwest away from Building 3; from a high point at MW-15 north of building 3 to a low point at MW-6 near the west side of the Site (corner of Jamison Road and Seneca Street). The difference in elevation, based on elevations of monitoring wells is approximately 16 feet. The surface cover at the Site is pervious mowed vegetative cover along the northern and western portions of the Site with a structure and impervious pavement in the southeast corner of the site. There is a paved asphalt entrance to the Site from Seneca Street and additional parking lot that abuts the southern portion of the Site.

Precipitation (i.e., rain or snow melt) moves to the storm drains via overland flow. There are two storm sewer trunk lines: 1) along the northern boundary of the site with an Outfall (006) at Seneca Street and Jamison Road; and 2) along the southern and western site boundary of the site with an Outfall (002) also at the corner of Seneca Street and Jamison Road. Surface water also infiltrates and become shallow groundwater.

2.3 Geology and Hydrogeology

2.3.1 Geology

The surface of the Site was observed to be approximately 0.5 ft of top soil in vegetated areas, asphalt in parking areas or concrete building foundations or walks. Subsurface soil is generally described as clay with sand or silty sand overlying shale bedrock. Bedrock at the Site was observed at depths from 5 to 23.5 fbgs.

2.3.2 Hydrogeology

Based on groundwater elevations measured on-Site, groundwater flows in a northwesterly direction. A groundwater isopotential map is provided as Figure 3.

2.4 Utilities and Groundwater Use

The subject property has access to all major public and private utilities including potable water (Erie County Water Authority), sanitary and storm sewers (on-site WWTP), electric (NYSEG), and natural gas (National Fuel).

Based on Town of Elma municipal records, the Site and surrounding properties are connected to a public drinking water supply. Based on a search of the NYSDEC website for water wells, the nearest wells are located approximately two miles north and south of the Site.

2.5 Wetlands and Floodplains

There are no State or Federal wetlands located on Site. According to the NYSDEC Environmental Resource Mapper, the nearest NYSDEC-regulated freshwater forested/shrub wetland (PFO1/SS1B) is located approximately 0.23 miles to the west of the Site. There are no State flood plains located on the Site.

2.6 RI Data Summary

Benchmark-TurnKey completed initial RI fieldwork in June-July 2017. In general and as summarized in the analytical summary tables previously provided, the initial RI findings included:

2.6.1 Surface/Near-Surface Soil/Fill

- Fourteen surface/near-surface soil/fill samples were collected during the RI.
- No volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals, polychlorinated biphenyls (PCBs), herbicides, pesticides or polyfluoroalkyl substances (PFASs) were detected above their respective 6NYCRR Part 375 Commercial Soil Cleanup Objectives (CSCOs).

2.6.2 Subsurface Soil/Fill

- Twenty-five test pits, nine exterior soil borings and nine interior soil borings were completed and a total of 55 subsurface soil samples were collected during the RI.
- No individual VOCs, SVOCs, PCBs, herbicides, pesticides or PFASs were detected above the Part 375 CSCOs.
- No individual metals were detected above the Part 375 CSCOs, with one minor exception. Arsenic was detected at MW-7 (4-6') at a concentration of 19 milligrams per kilogram (mg/kg), slightly above its Part 375 CSCO of 16 mg/kg.

2.6.3 Groundwater

- Nine new monitoring wells were installed, developed, and sampled and six existing monitoring wells were sampled during the RI.
- Based on groundwater elevations measured during the RI, groundwater flows toward the northwest. The east-west storm sewer appears to intercept and influence groundwater flow direction (see Figure 3).
- No individual SVOCs, PCBs, herbicides or pesticides were detected above the NYSDEC TOGS 1.1.1 Class GA Groundwater Quality Standards/Guidance Values (GWQSs/GVs).
- Total iron (2 locations), magnesium (1 location), manganese (1 location), and sodium (3 locations) were detected above their respective GWQSs/GVs.
- Several chlorinated VOCs (cVOCs), including 1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113), 1,1,1-trichloroethane (TCA), 1,1 dichloroethane (1,1 DCA), chloroethane, tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), trans-1,2-DCE and vinyl chloride, were detected in groundwater samples above their respective GWQS/GVs. Figure 4 shows cVOCs concentrations in groundwater and storm water.

2.6.4 Storm Water

- Seven water samples were collected from storm water manholes during the RI.

- Elevated concentrations of cVOCs, including 1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113), dichlorodifluoromethane, 1,1,1-trichloroethane (TCA), 1,1 dichloroethane (1,1 DCA), chloroethane, cis-1,2-DCE and 1,1-DCE were detected in storm water samples. Figure 4 shows cVOCs concentrations in groundwater and storm water.

2.6.5 Soil Vapor

- Six soil vapor (SV) samples and four sub-slab vapor/indoor air (SSV/IA) sample pairs (two each in Buildings 1 and 3) were collected during the RI.
- Based on the SSV/IA sample results, mitigation of Buildings 1 and 3 is planned.
- Soil vapor sample location SV-5, located in the northwest portion of the Site, had the highest concentrations of VOCs compared to the other SV samples.

2.7 Primary Constituents of Potential Concern (COPCs)

Based on findings to date, the Constituents of Potential Concern (COPCs) are chlorinated VOCs in groundwater, storm water, sub-slab vapor and soil vapor.

2.8 Supplemental Remedial Investigation Scope of Work

The Supplemental Remedial Investigation (SRI) scope of work is focused on further refining the extent of chlorinated VOCs in on-site groundwater and stormwater and obtaining additional data of sufficient quantity and quality to perform the alternatives analysis report.

Field team personnel will collect environmental samples in accordance with the rationale and protocols described in the QAPP in Section 4 of the RI/AA Work Plan. United State Environmental Protection Agency (USEPA) and NYSDEC-approved sample collection and handling techniques will be used. Samples for chemical analysis will be analyzed in accordance with USEPA SW-846 methodology with an equivalent Category B deliverable package to meet the definitive-level data requirements. Analytical results will be evaluated by a third-party data validation expert in accordance with provisions described in the QAPP. Data submittals will be provided to the NYSDEC in accordance with the most current electronic data deliverables (EDD) protocols.

During intrusive outdoor SRI activities, a Community Air Monitoring Plan (CAMP) will be followed. The CAMP is consistent with the requirements for community air monitoring at remediation sites as established by the NYSDOH and NYSDEC. Accordingly, it follows procedures and practices outlined under NYSDEC's DER-10 (May 2010) Appendix C1 (NYSDOH's Generic Community Air Monitoring Plan) and Appendix C2 (Fugitive Dust and Particulate Monitoring).

The investigation approach is described below. Figure 5 presents the planned SRI sample locations.

2.9 Field Investigation Activities

The additional site investigation will include advancement of soil boreholes (SBs), installation of permanent overburden and bedrock groundwater monitoring wells (MWs); and collection of groundwater and storm water samples. Representative samples will be placed in pre-cleaned laboratory provided sample bottles/containers, cooled to 4ºC in the field (as appropriate), and transported under chain-of-custody command to a NYSDOH Environmental Laboratory Approval Program (ELAP)-certified analytical laboratory.

2.9.1 Utility Clearance

Prior to any intrusive activities, Dig Safely New York (Call 811) will be contacted by the Site contractor a minimum of three business days in advance of the work and informed of the intent to perform excavation/intrusive work at the Site. If underground utilities are present on the property and anticipated to interfere with intrusive activities, the Applicant and NYSDEC will be contacted to discuss mitigating measures.

2.9.2 Soil Borings/Rock Cores

Nine (9) soil borings designated MW-16 through MW-24 and 9 rock cores designated MW-3D, MW-7D, MW-9D, MW-11D, MW-13D, MW-20D, MW-22D, MW-23D and MW-24D) will be completed at the approximate locations shown on Figure 5 to support monitoring well installation. Soil borings will be advanced at least five feet into the upper water bearing zone. Rock cores will be cored at least 10 feet into competent bedrock.

A field engineer/scientist/geologist will observe the soil borings, and create a field log (including photographs) for each location. Real time air and particulate monitoring will be conducted during intrusive activities using a PID and particulate monitor in accordance

with the CAMP. Soil/fill samples will be collected at two-foot intervals for classification, potential laboratory analysis, and field screening with a PID. Upon reaching the completion depth of each soil boring, visual/olfactory results will be reviewed. If warranted, one soil sample from each soil boring will be submitted for VOC analysis for any soil sample exhibiting sustained PID readings greater than 10 ppm.

Field personnel will be prepared to collect additional samples, in consultation with the Applicant and NYSDEC, if additional potential impacts are noted during the investigation.

2.9.3 Groundwater Investigation

Nine (9) additional overburden groundwater monitoring wells and nine (9) bedrock monitoring wells will be installed at the Site to further delineate groundwater flow direction and groundwater quality. Figure 5 identifies the planned groundwater monitoring well locations. Monitoring well installation, well development, and groundwater sample collection details are discussed in the following sections.

2.9.3.1 Overburden Monitoring Well Installation

For the overburden monitoring wells, the soil borings will be completed with a drill rig capable of advancing hollow stem augers to install 2-inch inside diameter PVC monitoring wells. Each well location will be advanced to approximately 15 fbgs, or refusal, with a target minimum of five feet below the first encountered groundwater. Non-dedicated drilling tools and equipment will be decontaminated between boring locations using potable tap water and a phosphate-free detergent (e.g., Alconox).

Subsequent to boring completion, a 2-inch ID diameter flush-joint Schedule 40 PVC monitoring well will be installed at each location. Each well will be constructed with a minimum 5-foot flush-joint Schedule 40 PVC, 0.010-inch machine slotted well screen. Each well screen and attached riser will be placed at the bottom of each borehole and a silica sand filter pack (size #0) will be installed from the base of the well to a maximum of two feet above the top of the screen. A bentonite chip seal will then be installed and allowed to hydrate sufficiently to mitigate the potential for downhole grout contamination. The newly installed monitoring wells will be completed with flush-mount casings over the riser, and lockable J-plugs with keyed-alike locks. Concrete will be placed in the boring around the protective casing and sloped away from the casing.

Drill cuttings will be placed in sealed NYSDOT-approved drums and labeled for subsequent characterization and disposal, if necessary. Drill cuttings without visual or olfactory evidence of impacts or sustained PID readings above 10 ppm may be placed on the Site.

2.9.3.2 Bedrock Monitoring Well Installation

For the bedrock monitoring wells, the soil borings will be completed with hollow stem augers to the top of competent bedrock. The augers will be removed from the boring and temporary flush joint casing will be installed to insure that the overburden is isolated while drilling the bedrock. Minimum ten feet of NQ-2 size core will be taken at each location and the bore hole reamed to a 4-inch nominal size. Subsequent to boring and rock core completion a 2-inch schedule 40 FJT PVC monitoring well will be installed in the completed bore hole with 5-foot of 0.010 slot screen installed in the bottom of the bore hole, #00N size morie sand pack, and a 3-foot bentonite seal. The remainder of the annular space will be tremmie grouted to ground surface and a 8-inch diameter roadbox installed in a small concrete pad will complete the well. Non-dedicated drilling tools and equipment will be decontaminated between boring locations using potable tap water and a phosphate-free detergent (e.g., Alconox). Appendix A contains the bedrock monitoring well installation field operating procedure (FOP).

2.9.3.3 Well Development

After installation, but not within 24 hours, the newly installed monitoring wells and piezometers will be developed in accordance with Benchmark-TurnKey and NYSDEC protocols. Development of the monitoring wells will be accomplished with dedicated disposable polyethylene bailers via surge and purge methodology. Field parameters including pH, temperature, turbidity, dissolved oxygen, oxidation-reduction potential (ORP) and specific conductance will be measured periodically (i.e., every well volume or as necessary) during development. Field measurements will continue until they become relatively stable. Stability will be defined as variation between measurements of approximately 10 percent or less with no overall upward or downward trend in the measurements. A minimum of three well volumes will be evacuated from each monitoring well. The development water will be containerized and either: characterized for proper disposal; treated with carbon and discharged to the ground surface; or, discharged into manhole location MH-G, which is

upstream of the on-site air stripper along Seneca Street. If light non-aqueous phase liquid (LNAPL), dense non-aqueous phase liquid (DNAPL), odors, or sheen are encountered during well development water will be containerized in NYSDOT-approved drums and labeled per monitoring well location. Containerized development water will be disposed off-Site or treated prior to surface discharge.

2.9.3.4 Hydraulic Conductivity Testing

Benchmark-TurnKey will complete hydraulic conductivity testing via slug tests on up to three monitoring wells on-Site, including at least two wells on the down-gradient portion of the Site, to assist in the assessment of groundwater flow velocity. This information will be instrumental for evaluating future potential groundwater remedies.

Slug tests are commonly used for evaluating the horizontal hydraulic characteristics (i.e., hydraulic conductivity or transmissivity) of a confined or unconfined aquifer or water-bearing zone in the immediate vicinity of a monitoring well (partially to fully penetrating). Slug tests are a non-pumping aquifer test whereby a known volume of water is quickly drawn from (e.g., rising-head test) or added to (e.g., falling-head test) the monitoring well and the rate at which the water level falls or rises back to static conditions is measured.

2.9.3.5 Groundwater Sample Collection

Sampling will be performed as soon as practical after purging as long as the well has recovered sufficiently to sample or within 24 hours after evacuation if the well recharges slowly. Prior to sample collection, static water levels will be measured and recorded from all on-site monitoring wells to facilitate the preparation of a Site-wide isopotential map. Following water level measurement, field personnel will purge and sample monitoring wells using a submersible pump with dedicated pump tubing following low-flow/minimal drawdown purge and sample collection procedures. In the event of pump failure or the saturated unit does not permit the proper implementation of low-flow sampling, a dedicated polyethylene bailer will be used to purge and sample the well. Prior to sample collection via low-flow methodology, groundwater will be evacuated from each well at a low-flow rate (typically less than 0.1 L/min) while maintaining a generally consistent water level. Field measurements for pH, temperature, turbidity, DO, ORP, specific conductance and water level, as well as visual and olfactory field observations will be periodically recorded and

monitored for stabilization. Low-flow purging will be considered complete when pH, specific conductivity, DO, ORP, and temperature stabilize and when turbidity measurements fall below 50 Nephelometric Turbidity Units (NTU), or become stable above 50 NTU regardless of volume purged. Purging via disposable bailer, if necessary, will be considered complete following the removal of three well volumes and field parameter stabilization or to well dryness, whichever occurs first. In general, stability is defined as variation between field measurements of 10 percent or less and no overall upward or downward trend in the measurements. Upon stabilization of field parameters, groundwater samples will be collected and analyzed.

Prior to, and immediately following collection of groundwater samples, field measurements for pH, specific conductance, temperature, dissolved oxygen, turbidity and water level, as well as visual and olfactory field observations will be recorded. Collected groundwater samples will be placed in pre-cleaned, pre-preserved laboratory provided sample bottles, cooled to 4ºC in the field, and transported under chain-of-custody command to a NYSDOH-approved laboratory for analysis.

2.9.3.6 Bench-Scale Groundwater Treatability Testing

As part of the final remedy, a passive reactive barrier "gate" wall is being contemplated in conjunction with a slurry wall to direct groundwater to the "gate". Water in the "gate" can be treated and cleaned to meet allowable groundwater discharge standards. One of the key tests to assess this technology is the collection of site groundwater representative of what will be collected by the slurry wall and "gate". Approximately 5 gallons of Site groundwater will be collected from up to three wells using the low-flow techniques prescribed above in Section 2.9.3.4 and sent to a third-party laboratory for treatability testing using column tests. The main objective of column tests is to estimate the half-life of the degradation reaction of Site contaminants. The half-lives of the organic contaminants and their byproducts then are used to select the reactive medium and/or to design an appropriate flow-through thickness for the reactive "gate". The testing will include running the groundwater through various media to determine the most cost-effective mixture to treat site contaminants. These data, along with Site hydraulic conductivity, existing analytical (e.g., cVOC concentrations) and field data (e.g., dissolved oxygen, oxidation-reduction potential), will be utilized to select and design a full-scale groundwater remediation remedy.

2.9.3.7 Groundwater Sample Analyses

Groundwater samples from each monitoring well will be collected and analyzed for Target Compound List (TCL) VOCs. The samples will include appropriate quality assurance/quality control (QA/QC) samples such as blind duplicates, matrix spike/matrix spike duplicates and trip blanks with an equivalent Category B (Level 4) data report. The data will be analyzed by an independent Environmental Laboratory Approval Program (ELAP)-approved laboratory on a standard turn-around time (i.e., approximately 10-15 business days).

2.9.4 Storm Water Investigation

Approximately 900 feet of storm sewer runs south, then east to west along the southern portion of the Site, and then turns and runs northerly, exiting the Site at Seneca Street via Outfall 002. Also, there is approximately 280 feet of sewer that connects to the east-west storm sewer system that drains to Outfall 006 on the northern portion of the Site that was not sampled during the RI which includes 6 manholes. As such, sixteen (16) storm water samples will be collected, including fifteen from storm water manholes/drop inlets; MH-P, MH-UNK, MH-N, MH-M, MH-L, MH-K, MH-D, MH-E, MH-F, MH-G, MH-H, MH-N(E), MH-M(E), MH-L(E), MH-D(E) and one from Outfall 002 (see Figure 5). The samples will be analyzed for the same parameters as groundwater samples (TCL VOCs). To prevent the possible dilution of contaminants in the storm sewer system, water samples will not be collected immediately after a storm event.

2.9.5 Sub-slab Communication Testing (Buildings 1 and 3)

The purpose of an ASD System is to create a negative sub-slab pressure relative to ambient air and to vent any potential contaminated vapors that migrate from the subsurface to the area beneath the building slab. As an initial step in the preliminary ASD System(s) design, we will mobilize an Engineer and Field Technician to the Site to conduct sub-slab communication testing. The testing will involve connecting a vacuum source (i.e., fan) to a hole (i.e., suction pit) drilled into the floor and measuring vacuum in incremental distances away from the vacuum source. This test will help determine the radius of influence from each suction pit and provide the information necessary to specify the number of suction pits and fans/blowers that will be necessary to properly vent the buildings. The testing procedure will include drilling holes, ranging from ½ inch to 5 inches in diameter, in the existing

concrete slab. The holes will be used to measure and/or create vacuum in the subsurface. The number of holes will be determined in the field in order to adequately assess communication within the subsurface areas of the buildings. Field data will be collected using digital manometers. Upon completion of the testing the holes will be backfilled with backer rod and urethane caulk or hydraulic cement, as appropriate.

The sub-slab communication testing results will be utilized to prepare a preliminary ASD System(s) Design Report for each building (i.e., Building 1 and Building 3). Vacuum vs. distance results will be plotted graphically and shown on Site maps. Benchmark-TurnKey will review pertinent construction plans and historic drawings and visit the Site to get familiar with the general site layout to help determine the most practical and cost effective location(s) of ASD system components, such as suction pits, piping and fans. The ASD System(s) Design Report will include recommendations of number of suction pits, piping layout, make and model of fans and discharge (vent) locations. The report will be provided to NYSDEC/NYSDOH for review, comment and/or approval.

2.10 Field Specific Quality Assurance/Quality Control Sampling

In addition to the groundwater, and storm water samples described above, field-specific quality assurance/quality control (QA/QC) samples will be collected and analyzed to ensure the reliability of the generated data as described in the QAPP (see Section 5.0) and to support the required third-party data usability assessment effort. Site-specific QA/QC samples will include matrix spikes, matrix spike duplicates, blind duplicates, and trip blanks..

2.11 Decontamination and Investigation-Derived Waste Management

Every attempt will be made to use dedicated sampling equipment during the SRI; however, if non-dedicated equipment is required and/or used, the equipment will be decontaminated, at a minimum, with a non-phosphate detergent (i.e., Alconox®) and potable water mixture, rinsed with distilled water, and air-dried before each use in accordance with Benchmark-TurnKey's FOPs presented in Appendix E of the RI/AA Work Plan. Decontaminated sampling equipment will be kept in a clean environment prior to sample collection. Heavy equipment, such as the drill rig and drilling tools, will be decontaminated by the subcontractor, as necessary.

Investigation-generated drilling spoils not exhibiting gross contamination (i.e., visible product, odor, sheen, elevated PID) will be either returned to the borehole from which it was removed (soil/fill); the development water or groudwater will be containerized and either: characterized for proper disposal; treated with carbon and discharged to the ground surface; or, discharged into manhole location MH-G, which is upstream of the on-site air stripper along Seneca Street. Investigative-derived waste (IDW), and those materials exhibiting gross contamination, will be placed in sealed NYSDOT-approved drums and labeled for subsequent characterization and disposal. IDW drums that are generated will be labeled alpha-numerically with regard to contents, origin, and date of generation using a paint stick marker on two sides and the top of each drum. Characterization analytical results of containerized IDW material will be used to determine if spoils can be returned to the ground surface, used on-site, or require treatment and/or off-site disposal. Drums will be securely staged on-site pending characterization analyses and remedial measures assessment. Field personnel will coordinate the on-site handling and temporary storage of IDW drums, including transportation, characterization sampling, and on-site treatment, as necessary.

Discarded personal protective equipment (PPE) (i.e., latex gloves, Tyvek, paper towels, etc.) and disposable sampling equipment (i.e., bailers or stainless steel spoons) will be placed in sealed plastic garbage bags and disposed as municipal solid waste.

2.12 Site Mapping

A Site map will be developed and include investigation locations and relevant Site features. Benchmark-TurnKey will employ a Trimble GeoXT handheld GPS unit to identify investigation locations relative to State planar grid coordinates. Monitoring well elevations will be measured by Benchmark-TurnKey's surveyor. An isopotential map showing the general direction of groundwater flow will be prepared based on groundwater elevation measurements relative to the North American Vertical Datum (NAVD) 1988.

3.0 INTERIM REMEDIAL MEASURES

This section of the Work Plan describes IRM activities including soil excavation monitoring, excavation-related groundwater and/or precipitation infiltration treatment, and community air monitoring. The final remedy for the Site will be determined in the Alternatives Analysis Report (AAR) upon completion of the comprehensive RI/SRI.

3.1 Utility Clearance

Prior to any intrusive activities, Dig Safely New York (Call 811) will be contacted by the site contractor a minimum of three (3) business days in advance of the work and informed of the intent to perform excavation work at the Site. If underground utilities are present on the property and are anticipated to interfere with intrusive activities, the Applicant and the NYSDEC will be contacted to discuss mitigating measures.

3.2 Soil Excavation Monitoring, Groundwater Treatment and Community Air Monitoring

3.2.1 Soil Excavation Monitoring and Community Air Monitoring

Moog received approval from NYSDEC on August 17, 2017 to remove approximately 20,000 cubic yards (CY) of soil that is planned for excavation in the area of the new buildings 1A and 3A; part of this proposal is related to that work. Benchmark-TurnKey will provide engineering oversight during soil excavation and off-Site transportation. The NYSDEC has approved the soil for acceptance at another BCP site(s) (C915198 J&L; C915197 C, E G, I, J & K); however, screening of the soil, storm water piping and bedding stone is required during soil removal. Existing storm water piping and bedding stone will be screened/investigated during the soil removal activities. Soil excavation will expose existing storm water piping and bedding; soil, storm water piping and surrounding bedding will be screened during soil removal to ensure impacted materials are not transported off-Site and to investigate potential impacts in and around the storm sewers. A Benchmark-TurnKey Environmental Engineer/Scientist will screen soils, storm sewer piping and surrounding bedding using a photoionization detector (PID) (equipped with an 11.7eV lamp) as well as visual and olfactory observations during soil load-out. In the event that impacted materials are encountered based on visual/olfactory evidence or sustained

PID readings above 10 ppm, Benchmark-TurnKey will assist in coordinating segregation of the materials, stockpiling and covering the materials on-site and identifying a suitable waste characterization plan and proper waste management plan (e.g., off-site transportation and disposal at a licensed commercial landfill, depending on concentrations of contaminants) in consultation with the Department.

Community air monitoring will need to be performed by a Qualified Environmental Professional (QEP) during earth moving and excavation activities in accordance with the Community Air Monitoring Plan (CAMP), which is a component of the Health and Safety Plan (HASP). Monitoring equipment will include a continuous recording particulate monitor with data logging capability and a PID for organic vapors, both of which will be located in three locations, per New York State Department of Health (NYSDOH) requirements for this project: two units along the Jamison Road BCP site perimeter of the on-Site work area; and, one unit upwind (to be determined each day). If monitoring indicates action limit exceedances (5 ppm organic vapor, 150 micrograms per cubic meter of airborne particulate) the excavation contractor will be informed and corrective actions will be required (e.g., applying a water spray). At a minimum, CAMP reports will include daily CAMP data and a figure showing work zones, CAMP monitoring stations, and wind directions. All individual CAMP exceedances and associated corrective actions will be communicated to the Department and NYSDOH within one day of the exceedance.

All observations and CAMP data will be documented for incorporation in the post-construction IRM report discussed below.

3.2.2 Backfill Screening

In accordance with criteria contained in NYSDEC DER-10 and per BCP requirements, all backfill soils imported to the Site will need to be free of visual/olfactory impact and meet commercial Soil Cleanup Objectives (SCOs) per 6NYCRR Part 375-6. Non-soil material (e.g., gravel, stone) are exempt from testing provided they meet certain gradation requirements and/or are approved for import under a beneficial use determination (BUD) under New York State solid waste (NYCRR Part 360) regulations. There is excess soil from previous construction projects located in another area of the Moog campus which may be used as backfill around foundations during construction of the new buildings 1A and

3A. Therefore, Benchmark-TurnKey will collect analytical samples for full suite analysis in accordance with Table 5.4(e)10 of NYSDEC DER-10. Approximately 1,000 CY of material will be required.

If other construction-related material (e.g., gravel) is planned for import, Benchmark-TurnKey will evaluate the contractor's source(s) of bedding and backfill for import and seek approvals for use from the NYSDEC.

3.2.3 Groundwater Treatment System Installation, Operation, Maintenance and Monitoring

Water removed from excavations by dewatering during the soil removal will be pre-treated in a groundwater treatment system (GWTS) on-site prior to discharge. Extracted groundwater or excavation water will either be treated using a bag filter and granular activated carbon, tested every 7,000-gallons and discharged to the ground surface or discharged into a nearby storm water manhole. Following completion of excavation work, settled solids remaining in the tank and spent filter bags will be containerized for off-site disposal. Spent GAC will be characterized (Total and TCLP testing for VOCs) and regenerated off-site, or disposed at a permitted treatment, storage and disposal facility (TSDF) in accordance with applicable federal and state regulations. The tank(s) will be decontaminated via pressure washing prior to removal.

3.2.4 Monitoring Well Decommissioning

During soil removal, monitoring wells located within the building footprint will be decommissioned either by direct removal (shallow wells) or in accordance with NYSDEC CP-43: Groundwater Monitoring Well Decommissioning Policy (MW-3D).

4.0 QUALITY ASSURANCE PROJECT PLAN

A Quality Assurance Project Plan (QAPP) has been prepared and is included in Section 4.0 of the RI/AA Work Plan.

5.0 INVESTIGATION SUPPORT DOCUMENTS

5.1 Health and Safety Protocols

TurnKey has prepared a Site-Specific Health and Safety Plan (HASP) for use by our employees in accordance with 40 CFR 300.150 of the NCP and 29 CFR 1910.120, and that is included in the RI/AA Work Plan.

5.1.1 Community Air Monitoring

Real-time community air monitoring will be performed during intrusive SRI and IRM activities at the Site in the same manner as the RI activities. A CAMP is included within Benchmark-TurnKey's HASP (see HASP Appendix C of the RI/AA Work Plan).

5.2 Citizen Participation Activities

NYSDEC prepared a Citizen' Participation Plan in July 2017 in support of this project.

6.0 REPORTING AND SCHEDULE

Upon completion of the SRI and IRM fieldwork, a comprehensive RI/AA Report will be completed summarizing the RI, SRI, IRMs and AA completed as described below in Section 6.1. The IRMs will be fully documented in a stand-alone IRM Closeout Report.

6.1 Supplemental Remedial Investigation Reporting

The SRI data will be incorporated in the RI/AA Report as described in the RI/AA Work Plan. Benchmark-TurnKey will document all SRI activities consistent with the NYSDEC's DER-10 Technical Guidance for Site Investigation and Remediation and include the supplemental RI data in the comprehensive Remedial Investigation/Alternative Analysis Report. Additional data and supporting information and materials will include boring logs, monitoring well construction diagrams, monitoring well development logs, groundwater elevation and sample location survey data, hydraulic conductivity testing results, bench-scale treatability results, laboratory analytical reports, etc. Site figures and groundwater isopotential maps will be updated and revised as necessary.

Benchmark-TurnKey will submit the SRI data to a qualified, independent data validation expert, who will prepare a DUSR with appropriate data qualifiers added to the results. The DUSR will follow NYSDEC format per the NYSDEC's September 1997 DUSR guidelines and DER-10 guidance. The DUSR and any necessary qualifications to the data will be appended to the RI report.

6.2 IRM Reporting

An IRM Construction Closeout Report will be prepared at the conclusion of the IRM activities. The report will include the following information and documentation, consistent with the NYSDEC's DER-10 Technical Guidance for Site Remediation:

- Introduction and background.
- A Site or area planimetric map showing the parcel(s) remediated, including significant site features.
- A Site map showing the lateral limits of soil excavation.
- Tabular summaries of unit quantities including: volume of soil excavated and disposition of excavated soil; volume of water extracted and treated; volume of

any sewer or other utility piping and piping contents removed; and, origin and volume of imported soil.

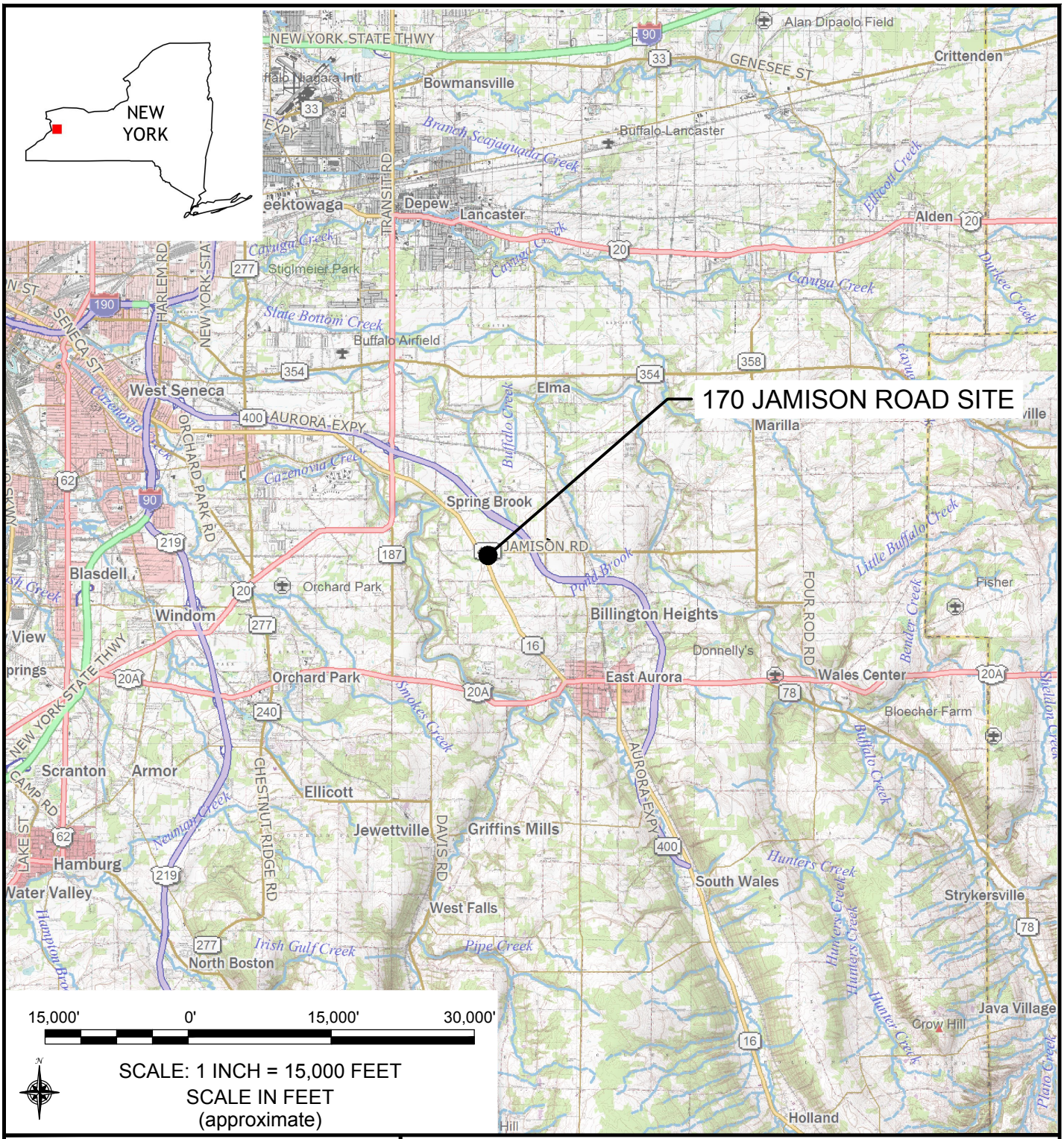
- Planimetric map showing location of all verification and other sampling locations (if any) with sample identification labels/codes.
- Tabular comparison of verification and other sample analytical results (if any) to Soil Cleanup Objectives.
- Documentation on the disposition of impacted soil (if any) removed from the Site.
- Record drawings of the ASD systems.
- Copies of daily inspection reports and, if applicable, problem identification and corrective measure reports.
- Photo documentation of interim remedial activities.
- Community air monitoring results.
- Text describing the interim remedial activities performed; a description of any deviations from the Work Plan and associated corrective measures taken; and other pertinent information necessary to document that the Site activities were carried out in accordance with the Work Plan.

7.0 PROJECT SCHEDULE

A tentative project schedule for the major tasks to be performed in support of the SRI/IRM is presented as Figure 6.

FIGURES

FIGURE 1



BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

2558 HAMBURG TURNPIKE
SUITE 300
BUFFALO, NY 14218
(716) 856-0599

PROJECT NO.: 0400-017-001

DATE: AUGUST 2017

DRAFTED BY: RFL

SITE LOCATION & VICINITY MAP

SRI-IRM WORK PLAN

170 JAMISON ROAD SITE
ELMA, NEW YORK

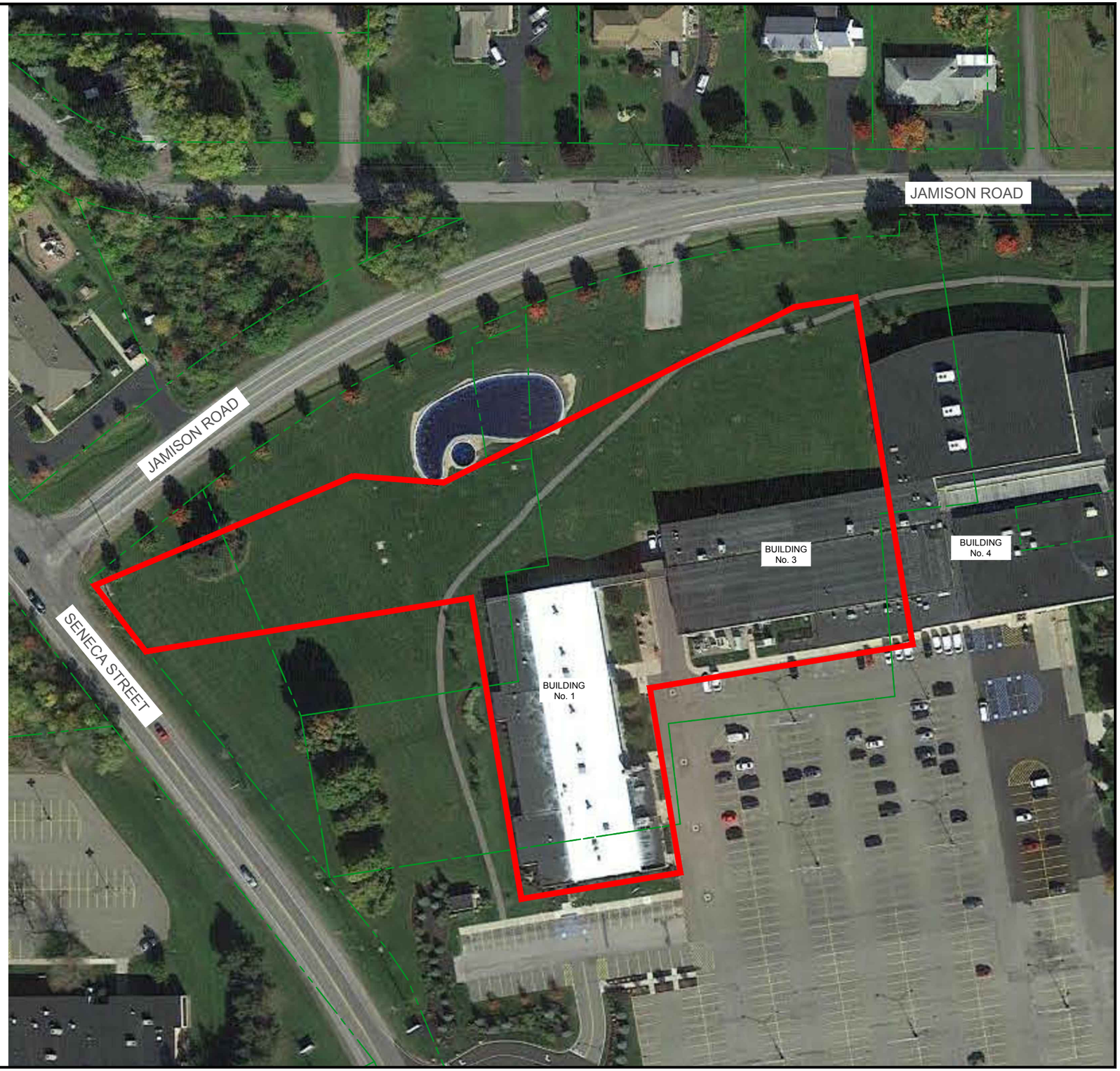
PREPARED FOR
MOOG INC.

LEGEND:

BCP SITE BOUNDARY

PARCEL BOUNDARY

NOTES:
1. GOOGLE IMAGE FROM OCTOBER 2016



N

100' 0' 100' 200'

SCALE: 1 INCH = 100 FEET
SCALE IN FEET
(approximate)

DATE: AUGUST 2017
DRAFTED BY: RFL

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BUFFALO, NY 14218
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JOB NO.: 0400-017-001

SITE PLAN

SRI-IRM WORK PLAN
170 JAMISON ROAD SITE
ELMA. NEW YORK

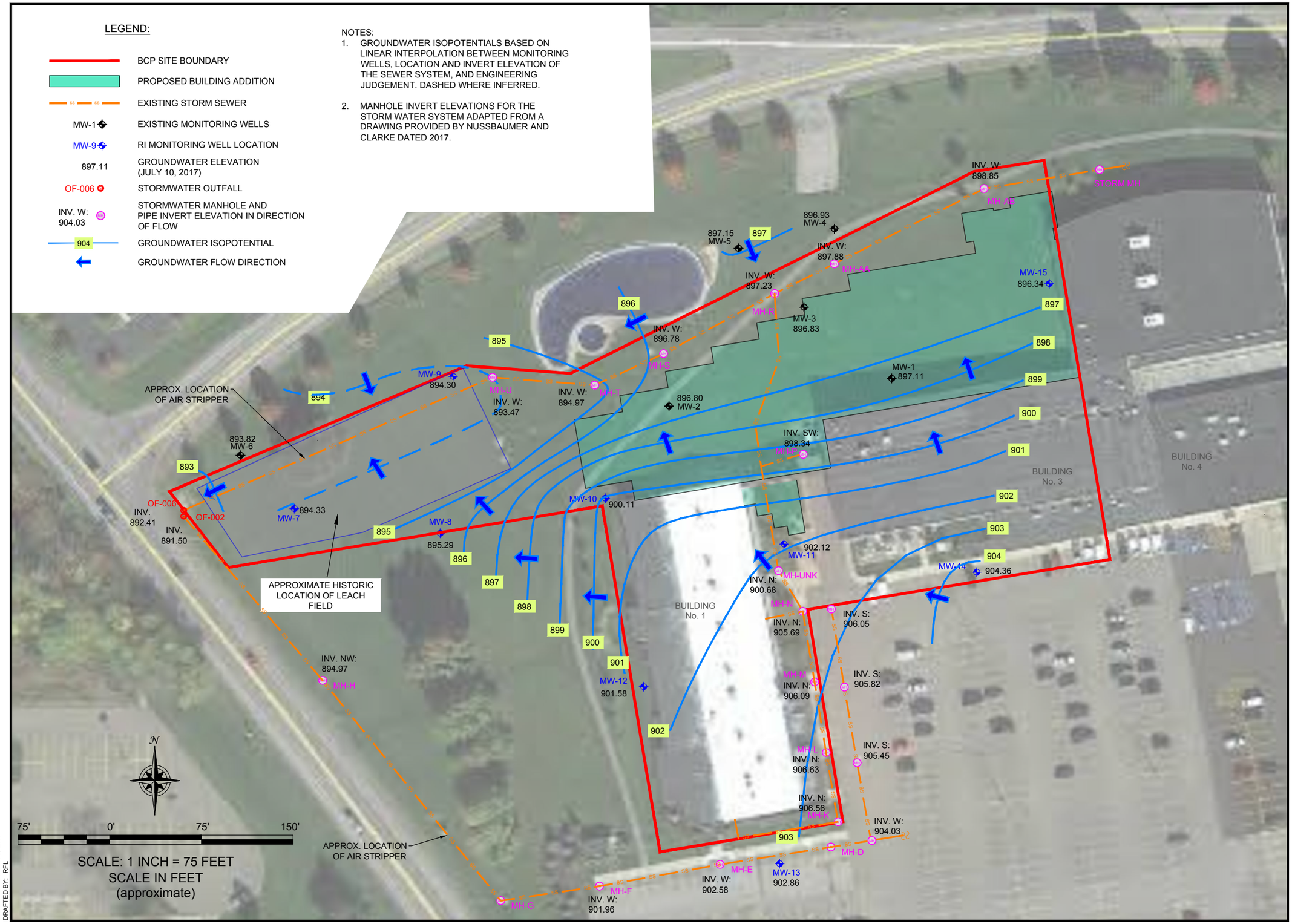
PREPARED FOR
MOOG INC.

FIGURE 2

LEGEND:

- BCP SITE BOUNDARY
- PROPOSED BUILDING ADDITION
- EXISTING STORM SEWER
- MW-1 EXISTING MONITORING WELLS
- MW-9 RI MONITORING WELL LOCATION
- 897.11 GROUNDWATER ELEVATION (JULY 10, 2017)
- OF-006 STORMWATER OUTFALL
- INV. W: 904.03 STORMWATER MANHOLE AND PIPE INVERT ELEVATION IN DIRECTION OF FLOW
- 904 GROUNDWATER ISOPOTENTIAL
- GROUNDWATER FLOW DIRECTION

NOTES:
1. GROUNDWATER ISOPOTENTIALS BASED ON LINEAR INTERPOLATION BETWEEN MONITORING WELLS, LOCATION AND INVERT ELEVATION OF THE SEWER SYSTEM, AND ENGINEERING JUDGEMENT. DASHED WHERE INFERRED.
2. MANHOLE INVERT ELEVATIONS FOR THE STORM WATER SYSTEM ADAPTED FROM A DRAWING PROVIDED BY NUSSBAUMER AND CLARKE DATED 2017.



DATE: SEPTEMBER 5, 2017
DRAFTED BY: RFL

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BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

JOB NO.: 0400-017-001

GROUNDWATER ISOPOTENTIAL MAP
JULY 10, 2017
SRI/IRM WORK PLAN

170 JAMISON ROAD SITE
ELMA, NEW YORK

PREPARED FOR
MOOG INC.

FIGURE 3

LEGEND:

- BCP SITE BOUNDARY
- PROPOSED BUILDING ADDITION
- EXISTING STORM SEWER
- FILTER BEDS
- MW-1 EXISTING MONITORING WELLS
- MW-13 RI MONITORING WELL LOCATION
- OF-006 STORMWATER OUTFALL
- PZ-1 PIEZOMETER
- MH MANHOLE

MH-U	
TCA	66
TCTFA	87
1,1 DCA	360
1,1 DCE	9.8
CIS 1,2 DCE	10

MH-T	
TCA	57
TCTFA	240
1,1 DCA	280
1,1 DCE	7.6
CIS 1,2 DCE	13

MH-S	
TCA	8
TCTFA	350
1,1 DCA	410
1,1 DCE	13
CIS 1,2 DCE	17

MH-R	
TCA	180
TCTFA	85
1,1 DCA	970
1,1 DCE	25.0

MW-3	
TCTFA	20
1,1 DCA	440
VC	13

MW-4	
1,1 DCA	3.3

MH-AB	
1,1 DCA	0.64

MW-5	
ND	

MH-AA	
1,1 DCA	3.2

MW-15	
TCTFA	2.2
1,1 DCA	110
VC	7.3

MW-9	
1,1 DCA	450
CIS 1,2 DCE	22
VC	36

MW-1	
TCTFA	30
1,1 DCA	7.8
VC	2.3

MW-2	
1,1 DCA	12
VC	1.7

MW-6	
1,1 DCA	330
VC	40

OF-006	
1,1 DCA	3

PZ-2	
1,1 DCA	3.1

PZ-1	
1,1 DCA	0.46

MW-10	
1,1 DCA	1.4
VC	7.7

MW-7	
TCTFA	680
1,1 DCA	1000
CIS 1,2 DCE	72
VC	77

MW-8	
TCTFA	130
1,1 DCA	240
CIS 1,2 DCE	27
VC	25

MW-11	
TCTFA	21
1,1 DCA	26
CIS 1,2 DCE	130
PCE	77
TRANS 1,2 DCE	21
TCE	33
VC	19

MW-14	
TCTFA	11

MW-12	
1,1 DCA	37
CIS 1,2 DCE	30
VC	12

MW-13	
TCA	110
TCTFA	810
1,1 DCA	120
CIS 1,2 DCE	53
TCE	56

APPROX. LOCATION OF AIR STRIPPER

APPROXIMATE LOCATION OF FILTER BED

FORMER APPROX. LOCATION OF 500-GALLON UST

APPROX. LOCATION OF AIR STRIPPER

BUILDING No. 1

BUILDING No. 3

BUILDING No. 4

SENECA STREET

OF-006

OF-002

MH-AD

ORM MH

MH-AA

MH-R

MH-T

MH-U

MH-H

MH-G

MH-F

MH-D

MH-K

MH-L

MH-M

MH-N

MH-UNK

MW-1 MW-2 MW-3 MW-4 MW-5 MW-6 MW-7 MW8 MW-9 MW-10 MW-11 MW-12 MW-13 MW-14 MW-15 PZ-1 PZ-2

LEGEND:

MW-4	
1,1 DCA	3.3

SAMPLE LOCATION

CONCENTRATION (ug/l)

COMPOUND

NOTES:

1. TCA = 1,1,1 TRICHLOROETHANE
   TCTFA = 1,1,2-TRICHLORO-1,2,2 -TRIFLUOROETHANE (FREON 113)
   1,1 DCA = 1,1 DICHLOROETHANE
   CIS 1, 2 DCE = CIS-1,2-DICHLOROETHENE
   TRANS 1, 2 DCE = TRANS-1,2-DICHLOROETHENE
   1,1 DCE = 1,1-DICHLOROETHENE
   PCE = TETRACHLOROETHENE
   TCE = TRICHLOROETHENE
   VC = VINYL CHLORIDE
2. ug/l = MICROGRAMS PER LITER
3. cVOC MEANS CHLORINATED VOLATILE ORGANIC COMPOUNDS LISTED ABOVE IN NOTE 3

75' 0' 75' 150'

SCALE: 1 INCH = 75 FEET
SCALE IN FEET
(approximate)

DATE: SEPTEMBER 5, 2017
DRAFTED BY: RFL

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JOB NO.: 0400-017-001

VOCs IN GROUNDWATER AND STORM WATER

SRI/IRM WORK PLAN
170 JAMISON ROAD SITE
ELMA, NEW YORK

PREPARED FOR
MOOG INC.

FIGURE 4

F:\CAD\Benchmark\Moog\170 Jamison Road\06 - SRI-IRM Work Plan\Figure 5Rev. GW and SW Sample Locations.dwg, DWG To PDF.pc3

75' 0' 75' 150'

SCALE: 1 INCH = 75 FEET
SCALE IN FEET
(approximate)

JAMISON ROAD

SENECA STREET

APPROX. LOCATION OF AIR STRIPPER

APPROXIMATE LOCATION OF FORMER LEACH FIELD

APPROX. LOCATION OF AIR STRIPPER

BUILDING No. 1

BUILDING No. 3

MW-1 MW-2 MW-3 MW-3D MW-4 MW-5 MW-6 MW-7 MW-7D MW8 MW-9 MW-9D MW-10 MW-11 MW-11D MW-12 MW-13 MW-13D MW-14 MW-15 MW-16 MW-17 MW-18 MW-19 MW-20 MW-20D MW-21 MW-22 MW-22D MW-23 MW-23D MW-24 MW-24D PZ-1 PZ-2

MH-AA MH-AB MH-E MH-F MH-G MH-H MH-K MH-K (E) MH-L MH-L (E) MH-M MH-M(E) MH-N MH-N(E) MH-P MH-R MH-S MH-T MH-U MH-UNK

OF-006 OF-002

STORM DI

LEGEND:

- APPROXIMATE PROPERTY BOUNDARY
- BCP SITE BOUNDARY
- PROPOSED BUILDING ADDITION
- EXISTING STORM SEWER
- FORMER LEACH FIELD
- MW-1 — PRE-RI MONITORING WELLS (MW-1 TO MW-6)
- MW-13 — RI MONITORING WELL (MW-7 TO MW-15)
- OF-006 — STORMWATER OUTFALL
- PZ-1 — PIEZOMETER
- MH-H — MANHOLE
- MW-16 — SRI MONITORING WELL PROPOSED; D INDICATES BEDROCK WELL
- SRI STORM WATER SAMPLE PROPOSED

DATE: OCTOBER 2017
DRAFTED BY: RFL

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JOB NO.: 0400-017-001

PLANNED GROUNDWATER AND STORM WATER SAMPLE LOCATIONS

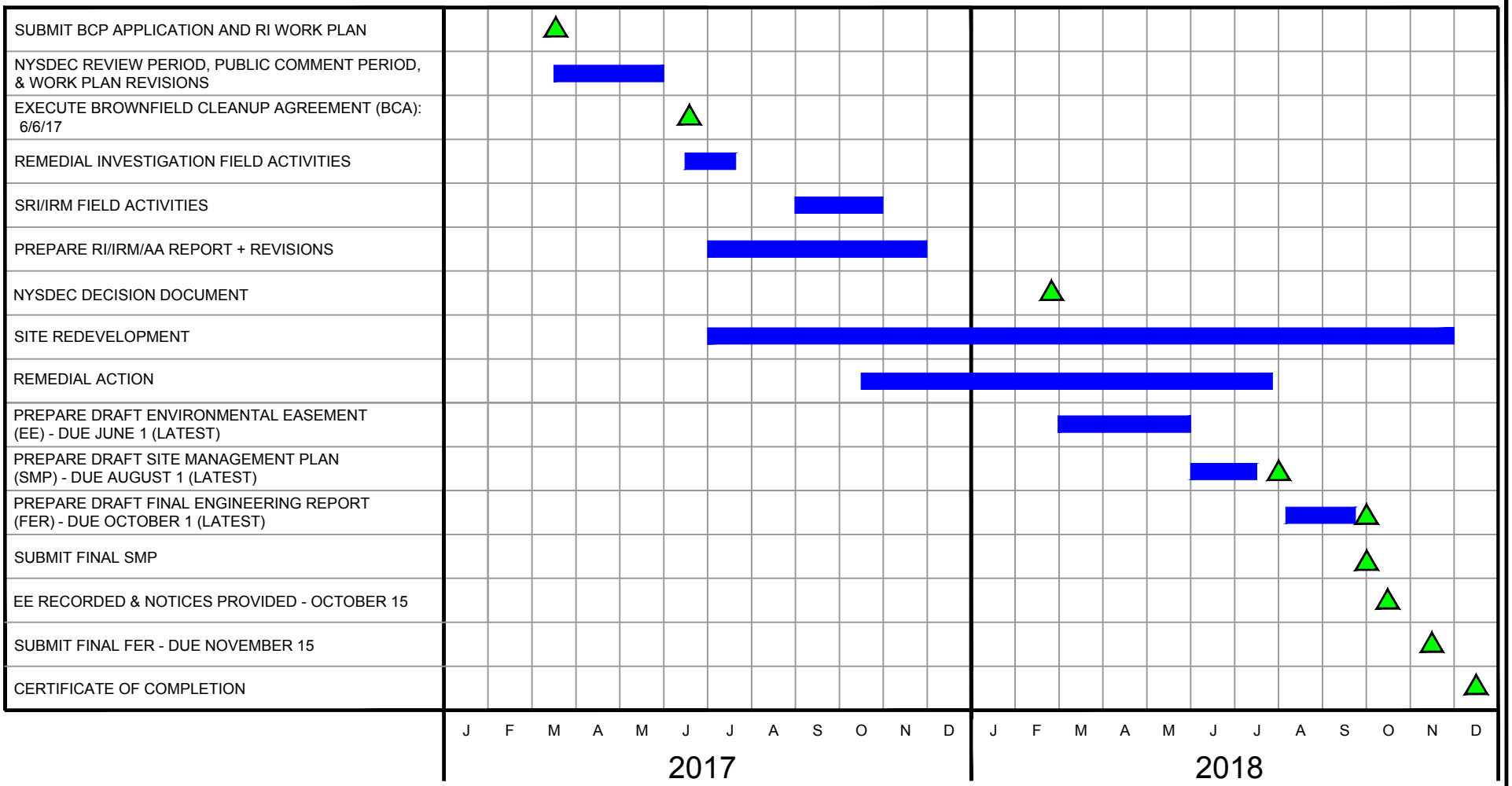
SRI/IRM WORK PLAN

170 JAMISON ROAD SITE
ELMA, NEW YORK

PREPARED FOR
MOOG INC.

FIGURE 5

PROJECT TASKS:



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(716) 856-0599

PROJECT NO.: 0400-017-001

DATE: SEPTEMBER 2017

DRAFTED BY: RFL

REVISED PROJECT SCHEDULE

SRI/IRM WORK PLAN

170 JAMISON ROAD SITE
ELMA, NEW YORK

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FIGURE 6

APPENDIX A

BEDROCK MONITORING WELL FOP

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

FIELD OPERATING PROCEDURES

Monitoring Well Construction in Bedrock

FOP 035.0

MONITORING WELL CONSTRUCTION IN BEDROCK

PURPOSE

This guideline presents a method for the construction of monitoring wells and piezometers in consolidated materials (i.e., bedrock).

PROCEDURE

1. Follow Benchmark's Drill Site Selection Procedure FOP prior to implementing any drilling activity.

2. Advance boring to top of competent bedrock as per Benchmark's Hollow Stem Auger (HSA) Drilling Procedures FOP and/or the Overburden Casing Installation Procedures FOP, or approved other as per the project work plan.

3. Advance the boring into consolidated bedrock by standard rock coring procedures (i.e., Benchmark's Air Rotary Drilling Procedure FOP or approved other as per the project work plan) using a triple wall core barrel of NX or HQ size. Log bedrock core in accordance with Benchmark's Rock Core Classification FOP. Temporary casing may be used if circulation of drill water is desired.

4. In the event of an over drill (i.e. borehole depth is more than one foot greater than desired base of screen depth), use bentonite chips poured through the auger stem to seal the over drilled portion of the borehole. Be sure to note bentonite chip thickness on Field Borehole/Monitoring Well Installation Log (sample attached).

5. Review the borehole/well installation program with the drilling contractor to ensure that the contractor has the necessary equipment and supplies and is familiar with the program requirements.

6. Perform packer permeability testing in accordance with Benchmark's Pressure Packer Test FOP as determined by project requirements.

7. Construct the open hole or screened well using appropriate materials identified in Benchmark's Well/Piezometer Construction Materials and Design FOP. Typical bedrock monitoring well construction is presented in Figure 1 (attached) and described in the following steps:

A. <u>Screened Installations</u>

a. Ream NX core hole to nominal 4-inch diameter with 3 ⅞-inch roller bit.

b. Verify borehole depth using weighted measuring tape. (Ensure that the rig is turned off and all equipment that may obstruct well installation or represent a safety hazard is removed.)

c. Add a minimum of two inches to a maximum of six inches of filter pack material of appropriate grade through the permanent or temporary casing to the base of the borehole. (Note: This step may be avoided if dense non-aqueous phase liquids are suspected to be present and it is desirable to have the screen at the base of the borehole or a well constructed with a sump (1 foot minimum).

d. Insert well screen and riser pipe equipped with centralizers located at the center of the well string and/or immediately above the well screen into borehole through the permanent or temporary casing.

e. Add filter pack materials to the screen section of the well through a tremie pipe while slowly backing temporary casing (if used) out of the borehole. The primary filter pack, when co0mplete, should extend no more than two feet above the well screen within the borehole. Measure the depth of the sand pack carefully and frequently with a weighted tape while adding sand.

f. Add a thin (6-inch) layer of secondary filter pack material above the primary filter pack as required.

g. Add bentonite pellet seal above the secondary filter pack and again remove the temporary casing slowly (if used). The bentonite seal should extend at least one foot above the top of the filter pack section. Measure the depth with a weighted tape. (Note: If bentonite seal is placed above the ground water level within the borehole, potable water should be added to hydrate the bentonite pellets.) The required hydration time for the pellets should be established prior to setting the seal. (Note: The position of the bentonite seal is dependent on the program requirements.)

h. Tremie grout into the remaining annular space under pressure to 3 feet below surface while slowly backing the HSA or temporary casing out of the borehole. Allow grout to set up for 6 to 12 hours, install protective casing, with surface weep holes, cap and lock. Complete concrete surface completion sloping away from protective casing. Under circumstances where the borehole is deep and the formation has a low hydraulic conductivity, it may be desirable to add potable water to the well prior to grouting to offset the pressure (weight) of the grout to minimize the potential for the grout to penetrate the sand pack.

i. Place a dedicated lock on the well or protective casing, and keep well locked when not actively attended.

j. Permanently label the well with the appropriate well identifier on the protective casing or install a permanent marker post as determined by the Project Manager or specified in the Work Plan.

k. Permanently mark a survey location on the north side at the top of the casing with a saw cut. Survey all wells for horizontal location and elevation, using a surveyor licensed by the State of New York. Coordinates and elevations will be provided in a coordinate system consistent with previous well surveys at the Site. Information obtained will include location (*x* and *y*) of the

well, and elevation (±) of the ground surface, the pad, and the top of riser.

l. Develop the well as described in the Benchmark Field Operating Procedure for Monitoring Well Development.

m. Manage all waste materials generated during well installation and development as described in the Benchmark Field Operating Procedure for Management of Investigation Derived Waste.

n. Document all soil/bedrock properties and sample locations (if any) in the Project Field Book and on Field Borehole/Monitoring Well Installation Logs (sample attached) in accordance with Benchmark's Field Operating Procedure for Documentation Requirements for Drilling and Well Installation. Specifically, total depth, depth of sample collection, personnel, etc.

B. Open Bedrock Installations

a. Open bedrock boreholes should only be used where the length of the open borehole is less than about twenty feet.

b. Once bedrock is encountered during conventional drilling using hollow stem augers or temporary casing the hollow stem augers or temporary casing should be seated into the top of bedrock. The rig should be converted to rock coring and the borehole advanced approximately five feet into bedrock or until two feet of competent bedrock is encountered, based on inspection of the rock core. The core hole should then be reamed using an appropriate sized bit to create a socket into the top of rock.

c. Verify borehole depth using weighted measuring tape. (Ensure that the rig is turned off and all equipment, which may represent a hazard, is removed.)

d. Appropriately sized permanent casing (containing a drillable plug at its base if tremie grout methods are used) should then be centered in the socket. Using tremie pipe, pressure packer or other methods, which introduce grout from the base of the annular space, grout the borehole annulus from bottom to top of borehole. An optional method involves grouting the bedrock socket and inserting the casing to the base of socket prior to the grout setting up. If a bentonite pellet s4eal is used at the base of the annular space before placement of the grout, a minimum of 60 minutes should be allowed for the bentonite to swell before grouting. Select the size and shape of the seal such that the bentonite can reach the socket and form a complete seal around the casing.

e. Allow 48 hours for the grout to set and assess the integrity of the grout seal by either filling the casing with potable water and monitoring water level decline or bailing the casing dry and monitoring any water level increase.

f. Drilling may proceed though the casing following hydrostatic testing of the grout seal, to create an open borehole to predetermined depth. After drilling is complete, install protective casing, with surface weep holes, cap and lock.

g. Place a dedicated lock on the well or protective casing, and keep well locked when not actively attended.

h. Permanently label the well with the appropriate well identifier on the protective casing or install a permanent marker post as determined by the Project Manager or specified in the Work Plan.

i. Permanently mark a survey location on the north side at the top of the casing with a saw cut. Survey all wells for horizontal location and elevation, using a surveyor licensed by the State of New York. Coordinates and elevations will be provided in a

coordinate system consistent with previous well surveys at the Site. Information obtained will include location (*x* and *y*) of the well, and elevation (*z*) of the ground surface, the pad, and the top of riser.

j. Develop the well as described in the Benchmark Field Operating Procedure for Monitoring Well Development.

k. Manage all waste materials generated during well installation and development as described in the Benchmark Field Operating Procedure for Management of Investigation Derived Waste.

l. Document all soil/bedrock properties and sample locations (if any) in the Project Field Book and on Field Borehole/Monitoring Well Installation Logs (sample attached) in accordance with Benchmark's Field Operating Procedure for Documentation Requirements for Drilling and Well Installation. Specifically, total depth, depth of sample collection, personnel, etc.

ATTACHMENTS

Field Borehole/Monitoring Well Installation Logs (sample)
Typical Monitoring Well Detail (Figure 1)

REFERENCES

New York State Department of Environmental Conservation, July 1988, *Drilling and Monitoring Well Installation Guidance Manual.*

Benchmark FOPs:
003 Air Rotary Drilling Procedure
015 Documentation Requirements for Drilling and Well Installation
017 Drill Site Selection Procedure
026 Hollow Stem Auger Drilling Procedures

032 Management of Investigation Derived Waste
036 Monitoring Well Development Procedures
041 Overburden Casing Installation Procedure
042 Pressure Packer Test Procedure
043 Rock Core Classification Procedure
070 Well/Piezometer Construction Materials and Design

MONITORING WELL CONSTRUCTION IN BEDROCK

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

FIELD BOREHOLE/MONITORING WELL INSTALLATION LOG

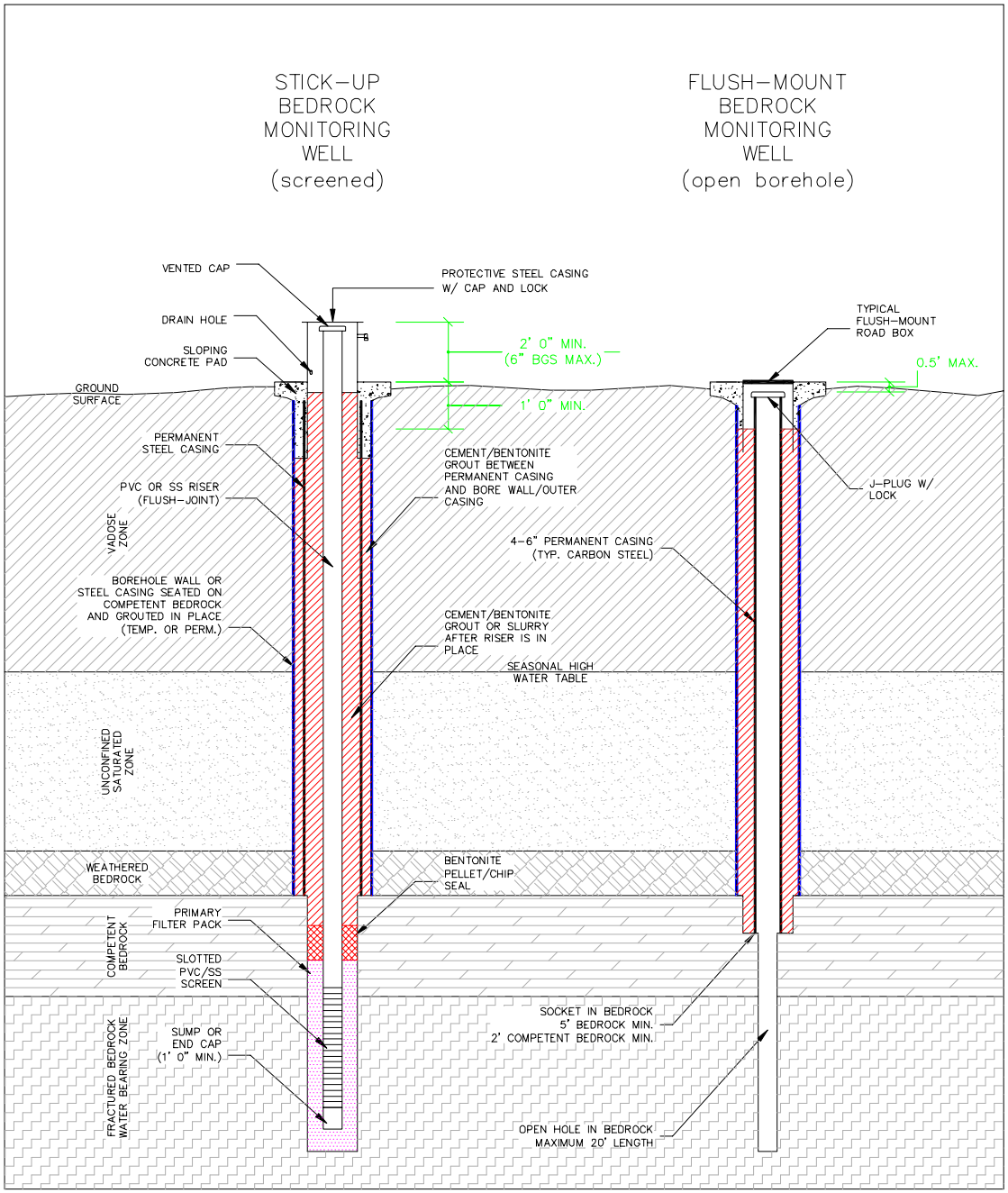
PROJECT:		**Log of Well No.:**	
BORING LOCATION:		ELEVATION AND DATUM:	
DRILLING CONTRACTOR:		DATE STARTED:	DATE FINISHED:
DRILLING METHOD:		TOTAL DEPTH:	SCREEN INTERVAL:
DRILLING EQUIPMENT:		DEPTH TO WATER: FIRST: / COMPL.:	CASING:
SAMPLING METHOD:		LOGGED BY:	
HAMMER WEIGHT:	DROP:	RESPONSIBLE PROFESSIONAL:	REG. NO.

Depth (fbgs)	SAMPLES: Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery	PID Scan (ppm)	SAMPLE DESCRIPTION USCS Classification: Color, Moisture Condition, % of Soil Type, Plasti Fabric, Bedding, Weathering/Fracturing, Odor, Oth SURFACE ELEVATION (FMSL):	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS

Project No:	Benchmark Environmental Engineering & Science, PLLC	Figure

MONITORING WELL CONSTRUCTION IN BEDROCK

FIGURE 1



APPENDIX B

ELECTRONIC COPY