GZA GeoEnvironmental, Inc.

Engineers and Scientists

January 25, 2016
File No. 05.0043654.00

Via E-Mail and U.S. Mail

Mr. Joseph Martella
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Re: Short Term Response Action Plan – South Washout Area
Former Tidewater Facility
200 Taft Street
Pawtucket, Rhode Island
RIDEM File No. SR-26-0934

Dear Mr. Martella:

On behalf of the Narragansett Electric Company d/b/a National Grid (National Grid), GZA GeoEnvironmental, Inc. (GZA) is pleased to present to the Rhode Island Department of Environmental Management (RIDEM) the attached *Short Term Response Action Plan (STRAP)* for the South Washout Area.

This STRAP has been prepared to address a sinkhole or "washout" located in the south fill area (SFA) portion of the Site, identified on previous report figures as the "South Washout Area". Two surface water discharge pipes are located at the western edge of the washout area which extends approximately 60 feet inland from the bank of the Seekonk River. These surface water discharge pipes originate beyond the eastern edge of Max Read Field and convey stormwater from the field and other upland areas. This area appears to have resulted from the deterioration of a headwall structure and subsequent erosion of surficial fill materials from surface water flow.

A Public Involvement Plan (PIP) dated October 2013 was approved by RIDEM for this Site. This PIP was prepared consistent with Rule 7.07 (Public Involvement) of the Remediation Regulations and is intended to be an agreement between National Grid and the public about how information will be shared and how the public will be able to comment on plans for assessment and cleanup of the Tidewater Site. As described further in the *STRAP*, the procedures for public involvement described in the PIP will be followed for this *STRAP*.

Should you have any questions or comments regarding the information presented herein, please do not hesitate to contact the undersigned or Michele Leone from National Grid at (401) 784-7337.

Very truly yours,

GZA GEOENVIRONMENTAL, INC.

Margaret S. Kilpatrick, P.E.
Senior Project Manager

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Consultant Reviewer

James J. Clark, P.E.
Senior Principal

Attachment: *Short Term Response Action Plan – South Washout Area*

cc: Michele Leone, National Grid
Elizabeth Stone, RIDEM

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SHORT TERM RESPONSE ACTION PLAN (STRAP)
SOUTH WASHOUT AREA
FORMER TIDEWATER FACILITY
200 TAFT STREET
PAWTUCKET, RHODE ISLAND

PREPARED FOR:
RIDEM
Providence, Rhode Island

PREPARED BY:
GZA GeoEnvironmental, Inc.
Providence, Rhode Island

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1.0 INTRODUCTION

On behalf of The Narragansett Electric Company d/b/a National Grid (National Grid), GZA GeoEnvironmental, Inc. (GZA) is pleased to present to the Rhode Island Department of Environmental Management (RIDEM) this *Short-Term Response Action Plan (STRAP)* for the former Tidewater Manufactured Gas Plant (MGP) and Power Plant located in Pawtucket, Rhode Island (herein referred to as the “Site”). A Site Locus Plan is presented on Figure 1, *Cover Sheet and Locus Plan*.

This *STRAP* has been prepared to address applicable requirements of Section 6.00 – Emergency or Short Term Response, of the RIDEM Rules and Regulations for the Investigation and Remediation of Hazardous Materials Releases (Remediation Regulations).

This *STRAP* is subject to the limitations included in Appendix A.

1.01. PROJECT OBJECTIVE

This *STRAP* has been prepared to address a sinkhole or “washout” located in the south fill area (SFA) portion of the property, identified on previous report figures as the “South Washout Area”. As described further herein, the scope of this *STRAP* involves repair of an existing surface water drainage feature via the installation of two new concrete manholes, approximately 60 linear feet of new drain line, an engineered outfall and restoration of the washout to match existing grade. The *STRAP* activities are expected to require 3 to 4 weeks to complete.

The “South Washout Area” appears to have resulted from the deterioration of a headwall structure and subsequent erosion of surficial fill materials from surface water flow. Two surface water discharge pipes are located at location of the deteriorated headwall structure located at the western edge of the washout area which extends approximately 60 feet inland from the bank of the Seekonk River. These surface water discharge pipes originate beyond the eastern edge of Max Read Field and convey stormwater from the field and other upland areas. Photographs of the outfall pipes and the washout area are included in Appendix B.

Based on recent discussions with the City of Pawtucket, we understand that upgrades to Max Read Field are planned. As described further herein, to facilitate coordination of these efforts, the current plan is to perform the *STRAP* activities described herein concurrent with the Max Read Field Upgrade project. Depending on the timing of the Max Read Field upgrade project, National Grid may elect to perform these STRAP activities independent of the City’s project. Further information about the proposed field upgrades is presented in Section 4.0.

A Public Involvement Plan (PIP) dated October 2013 was approved by RIDEM for this Site. This PIP was prepared consistent with Rule 7.07 (Public Involvement) of the Remediation Regulations and is intended to be an agreement between National Grid and the public about how information will be shared and how the public will be able to comment on plans for assessment and cleanup of the Tidewater Site. As described further in Section 8.0, the procedures for public involvement described in the PIP will be followed for this *STRAP*.

As described further in Section 6.0, consistent with previous air monitoring programs used for similar size/scope projects performed at the Site, an air monitoring program consistent with the April 2011 *Air Quality Monitoring Plan (AQMP)* will be implemented during these *STRAP* activities.

2.0 BACKGROUND

The following sections present a brief summary of background information for the Site, with focus on the South Washout Area, including relevant historic operations, regulatory history and status, nature and extent of environmental impacts. For more details regarding the existing and historic Site conditions, including Site plans, previous Site investigations, hydrogeologic setting and observed impacts, please refer to the January 2011 *Site Investigation Data Report (SIDR)*, the July 2011 *Remedial Alternative Evaluation (RAE)* and other reports previously submitted to the RIDEM. Reports and other RIDEM submittals between 2009 and present are available on the Tidewater website (www.tidewatersite.com).

2.01. SITE DESCRIPTION

The Site is located at the terminus of Tidewater Street and Merry Street in the City of Pawtucket, Rhode Island. The Site is located on the west side of the Seekonk River and is bound to the west by residential properties, to the south and southwest by the Francis J. Varieur School and Max Read Athletic Field, and to the north by undeveloped property owned by the City of Pawtucket. It encompasses approximately 23 acres and was the location of the former Tidewater MGP and the Pawtucket No. 1 Power Station. The Site is currently largely vacant with the exception of an active natural gas regulating station, an active switching station and electric substation, and two transmission towers owned and operated by National Grid. The Site is secured with a locked perimeter chain-link fence.

The Site is situated between Taft Street, an extension of Tidewater Street and Thornton Street to the west, the Seekonk River to the east, and consists of approximately 23 acres across seven separate lots. The majority of the Site is owned by National Grid and a small portion of the Site is owned by the City of Pawtucket. As described in previous reports, the Site includes the following four areas.

- North Fill Area (NFA) (northern portions of Assessors Plat (A.P.) 54B Lot 826);
- Former Gas Plant Area (FGPA) (southern portions of A.P. 54B Lot 826 and A.P. 65B Lot 662);
- Former Power Plant Area (FPPA) (A.P. 65B Lot 645); and
- SFA (A.P. 65B Lots 647 and 649, portions of Lot 648 and portions of A.P. 67B Lot 11).

The majority of work associated with this *STRAP* is planned to be conducted on A.P. 65B Lots 647, 648 and 649. Lot 648 is owned by the City of Pawtucket and as shown on the attached Figures, includes a portion of the Max Read Field as well as the washout area which is referred to herein as the "Work Area". Lots 647 and 648 are owned by National Grid and are vacant.

Figure 2, *Exploration Location Plan* presents existing features, configuration, approximate property boundaries and locations of explorations performed in the Former Power Plant Area and the South Fill Area. Figure 3, *Site Construction Access and Existing Conditions Plan* presents a detail of the current conditions of the South Washout Area. The Work Area is shown on both Figure 2 and 3.

2.02. REGULATORY HISTORY AND ENVIRONMENTAL OVERVIEW

MGP operations at the Site began in the 1880s and were substantially concluded in 1954, although peak shaving operations continued until the late 1960s. Power plant operations were conducted at the Site for approximately 85 years, between sometime in the early 1890s, when construction of the power plant began, until the facility ceased operation in 1975. During this timeframe, the power plant and MGP used coal and petroleum based products for manufactured gas and electricity generation. The SFA was primarily vacant during the operational history of the MGP and power plant.

An SIDR was submitted to RIDEM in January of 2011. This SIDR was prepared consistent with applicable sections of Rule 7.00 of the RIDEM Remediation Regulations. A *RAE* was submitted to RIDEM on July 29, 2011. This evaluation, combined with the January 2011 SIDR, fulfilled the requirements of Sections 7.03, 7.04, and 7.05 of the Remediation Regulations for a *Site Investigation Report* (SIR).

Soils proximate in the Work Area consist of fill underlain by estuarine deposits, glacial till and bedrock. The fill is estimated to be over 20 feet in thickness and consist of sand, coal, slag, ash and building debris. Certain of the fill material proximate to the Work Area are impacted by former MGP residuals (purifier box waste material and coal tar).

Exceedances of the RIDEM Method 1 Industrial/Commercial Direct Exposure Criteria (I/C-DEC) due to the presence of total petroleum hydrocarbons (TPH), polynuclear aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs) and certain inorganic compounds (primarily arsenic and lead) have been detected within the Work Area. In addition, more sporadic exceedances of the Method 1 GB Leachability Criteria and Upper Concentration Limit (UCL) were noted in soils proximate to the Work Area. Dense non-aqueous phase liquid (DNAPL) was observed adjacent to the riverfront within groundwater monitoring wells MW-1 and MW-320S/D. Naphthalene and benzene have been detected at concentrations in excess of RIDEM GB Groundwater Objective in MW-320D.

2.03. SOUTH WASHOUT AREA

Figure 3, *Site Construction Access and Existing Conditions Plan* presents the configuration of the washout area (and the Work Area) based on a field survey performed by GZA. Based on the field information gathered by GZA, the South Washout Area covers an area, oriented in an approximate southwest-northeast direction, which extends approximately 60 feet to the bank of the Seekonk River. The area ranges in width between approximately 10 to 38 feet and is approximately 13 feet deep at its deepest point. This area was surrounded with chain link fencing by National Grid in 2010 as a safety measure to prevent unauthorized access to this washout area.

Two surface water discharge pipes are located within the western bank of the washout area. The remnants of a storm drain structure appear to be located in the washout below these lines, suggesting that the two pipes were once connected to a manhole structure. Based on GZA field observations, it appears that these pipes originate from the Max Read Field area and likely convey stormwater from upland areas. As described previously, the washout appears to have resulted from erosion of materials from surface water flow originating from these drain lines. Photographs of the South Washout Area and drainage piping are included in Appendix B.

3.0 PROPOSED RESPONSE ACTIONS

The objectives of this *STRAP* are to address potential risks posed by unauthorized access to the South Washout Area (i.e., continued erosion/slope stability issues) and repair the drainage feature to prevent future erosion.

As described in the July 2011 *RAE* which is currently being reviewed by RIDEM, the proposed remedy for the SFA, including this Work Area, is an engineered cap, monitoring, and certain use restrictions. The *STRAP* activities described below will be designed and constructed such that the proposed engineered cap for this area can be implemented as part of the overall Site remedy.

- Access Road Construction: Work will be performed to create necessary construction access the Work Area and washout. This will likely involve constructing an access road from the vehicle gate at the fence line between the FPPA and SFA to the washout and may also include an access road to the fence line with the Max Read Field.

- Clearing and Grubbing: The Work Area will be cleared to facilitate the stormwater system repairs and subsequent backfill of the washout. This will involve removal of certain existing brush and trees as well the remnants of the former stormwater drainage structure.

- Temporary Erosion and Sedimentation Controls: Temporary erosion controls will be installed around the work perimeter. Temporary erosion controls will consist of 12-inch diameter compost logs with silt fencing. A silt curtain will also be installed directly down gradient of the washout outfall to prevent sediment transport to the Seekonk River during construction activities.

- Drainage Structure and Piping Repair: Work will be performed to repair the drain outfall and stabilize the river bank area within the washout. This is anticipated to include a new concrete manhole installation for the two existing drain pipes near the western end of the washout. A new drain line will then be installed, extending from western manhole to the river's edge. An additional drop manhole will be installed along this new pipe section to reduce water velocity and scour at the pipe outlet. To install the new manholes and associated drain line, the washout void will be graded to the necessary elevations. The washout area will be lined with a geotextile demarcation layer prior to placement of any fill material over existing grades. The outfall of this drain line was specifically designed to limit future erosion and sediment migration to the Seekonk River. The proposed repair work is shown on Figure 4 – *Proposed Condition Plan* and Figure 5 – *Erosion Control and Vegetation Restoration Plan*. Details associated with the proposed work are presented on Figures 6 and 7.

- South Washout Restoration: After completing the repair of the drainage structure and drain line, the washout void will be backfilled to match surrounding grades. The drain line was specifically designed to withstand the load from these fill materials. Based on completed survey work, it is estimated that approximately 400 to 500 cubic yards (CY) of fill material will be required. The fill material will consist of clean imported material consisting of a bedding sand overlain by gravel fill overlain with loam. Hydroseed, and bio-degradable erosion control mats will be utilized to stabilize the backfilled area and limit the potential for erosion. In addition, straw log check dams will be installed at 50 foot intervals along the restored slope to reduce the potential for erosion until vegetation is established.

3.01. IMPORT SAMPLING

Samples representative of any off-Site imported soil (collected as discrete grab samples from the source) will be tested for the analyte groups described below. As described above, bedding sand, gravel fill and loam are expected to be imported to the Site as part of the *STRAP* activities. Alternatively, the imported soil can be certified as non-jurisdictional by an environmental professional.[1]

Analyte	EPA Test Method
Total Petroleum Hydrocarbons	8100M
Volatile Organic Compounds	8260
Semi-Volatile Organic Compounds	8270
Priority Pollutant Metals (PP-13)	6010 & 7471A

The frequency of sampling and testing will be:

- Full suite of analysis for up to 2,000 cubic yards, with an additional full suite for each subsequent 2,000 cubic yards of material; and
- Arsenic each 500 cubic yards of material.

Laboratory samples will be collected by GZA and submitted for laboratory analysis. The contractor will be informed that the supply must meet RIDEM Method 1 Criteria. Soils not meeting these criteria will be rejected for use at the Site. The laboratory testing results of the approved soil source(s) will be provided to RIDEM as part of the *Short Term Response Action Report*.

3.02. REPORTING

Subsequent to completion of the activities described herein, a *Short Term Response Action Report* will be prepared in accordance with Rule 6.09 of the Remediation Regulations. The report will summarize field activities and document the completion of the work described herein.

[1] Non-jurisdictional generally indicates that the soil has no fines present (i.e. crushed stone) or is from a certified native, uncontaminated source. Bedding sand is typically determined to be non-jurisdictional.

4.0 PROPOSED MAX READ FIELD UPGRADES

The City of Pawtucket is planning on upgrading Max Read Field. Based on recent discussions with the City of Pawtucket and RIDEM, we understand these upgrades are currently planned for the summer of 2016. As described previously, depending on the schedule of this *STRAP* and the City project, they may be performed concurrently. It is our understanding that the proposed upgrades to the Max Read Field consist of the design and construction of a synthetic turf multi-use field.

According to the City of Pawtucket, approximately 2,500 CY of excess soils may be generated as part of the upgrade activities. As discussed recently with RIDEM and the City, pending RIDEM approval, certain of these excess materials may be transported to the Tidewater Site for future use in establishing subgrade beneath the proposed Site-wide engineered cap. These materials will be placed in a low-lying area (likely in the FPPA) and protected from erosion by covering the pile with erosion control netting or a geotextile fabric and utilizing straw wattles around the pile.

In addition, while the proposed field upgrade plans have not been finalized, it is possible that some areas of MGP-impacted soils may be encountered during the work along the eastern edge of Max Read Field. In the event that MGP-impacted soils are encountered during this work, National Grid will work with the City such that these materials are property managed and disposed off-Site.

5.0 ESTIMATED AIR EMISSIONS DUE TO EARTHWORK

Implementation of this *STRAP* will involve limited earthwork activities including clearing and grubbing the washout area, setting two concrete structures to act as drop manholes and constructing access roads. As part of the *STRAP* activities, consistent with previous earthwork projects completed at the Site, GZA performed an evaluation of the potential volatile emissions including a determination related to the applicability of the RIDEM Air Pollution Control Permits (APC) (Regulation No. 9).

The applicability of Regulation No. 9 was evaluated based on potential volatile emissions calculations/modeling performed consistent with published United States Environmental Protection Agency (EPA) guidance. This emissions modeling was developed for the specific earthwork activities to be performed during this effort. As described further herein and in the attached, the results of this modeling indicate that construction of the remedy **does not** have the potential to increase emissions by greater than the minimum quantities specified in Appendix A of RIDEM APC Regulation No. 9, and, therefore, a minor source permit is not required for this activity.

5.01. EMISSIONS POTENTIALS

The emissions potential of a particular analyte was calculated by assuming all of the mass of the analyte volatilizes during the associated earthwork activities. This would represent the maximum amount of mass of the specific analyte in the volume of soil being excavated and managed on-Site. It is based on analyte concentration, soil volume disturbed, and typical bulk density. The predicted modeled emissions, described in the subsequent section, are generally lower than these calculated emissions potentials.

A limited volume of soil is planned to be excavated and likely reused as backfill during the *STRAP* activities (i.e., South Washout Area grading and backfilling with clean imported material, access road construction). It is anticipated that these activities will involve management of approximately 890 CY of excavated soils[2]. To evaluate the excavation emissions potentials and modeled excavation emissions, GZA used data collected in the vicinity and at the depths of expected excavation associated with the *STRAP* work. The data used in the evaluation consisted of 26 soil samples collected by GZA and others between 1986 and 2010, as presented in the January 2011 SIDR. The data is presented in Table C-1 (in Appendix C). The calculations only utilized soil samples collected within 100 feet of the proposed *STRAP* activities (the Work Area) and within the upper 10 feet of soil. Exploration locations in the Work Area are presented on Figure 2, Exploration Location Plan.

Using both the average and maximum concentrations for the potential calculation, GZA conservatively calculated the total emissions potential (in pounds (lbs)) for all the detected VOCs with minimum quantities included in Appendix A of RIDEM's APC Regulation No. 9. This calculation assumes all the mass of the VOCs in the associated soil is emitted, providing conservative upper bounds to potential excavation emissions. As indicated in Table C-2 (in Appendix C), benzene and naphthalene have an excavation emissions potential exceeding the RIDEM annual minimum quantities (10 lbs/year and 3 lbs/year, respectively) based on both the average and maximum measured concentrations. Based on these calculations, benzene and naphthalene were further evaluated using emissions modeling consistent with published EPA guidance to estimate the predicted emissions that would be generated during the planned *STRAP* implementation activities.

5.02. EMISSIONS MODELLING

Based on the results of the emissions potentials calculations described above for the earthwork activities, predicted emissions related to benzene and naphthalene were calculated based on modeling. The predicted emissions modeling used the average concentration of benzene and naphthalene that was detected. Appendix C describes these

[2] The emission calculations conservatively assume a factor of safety of 2 with respect to soil volume.

emission modeling calculations, which were based on the following EPA guidance document:

- Eklund, et al. 1997. Air Emissions from the Treatment of Soils Contaminated with Petroleum Fuels and Other Substances. Prepared for U.S. Environmental Protection Agency Office of Air and Radiation and Office of Research and Development Washington, D.C. EPA-600/R-97-116. October.

The modeling results for the excavation activity are presented in Table D-3. GZA assumed that one re-handling event would occur for each of the earthwork activities when the excavated soil was loaded from stockpiles to trucks for subgrade backfilling on Site or for disposal. Excavation emissions were calculated including the emissions associated with these re-handling events, as well.

Table C-3 (in Appendix C) and the following presents a summary of the modeled predicted total excavation emissions for benzene and naphthalene (expressed in pounds) compared to RIDEM's Minimum Quantities (expressed in pounds/year) published in Regulation No. 9, Appendix A.

Analyte	Total Modeled Excavation Emissions (lbs)	RIDEM Annual Minimum Quantity (lbs)
Benzene	2.11	10
Naphthalene	0.09	3

5.03. ESTIMATED EMISSION MODELLING CONCLUSIONS

The results of this predictive modeling indicate that the earthwork activities do not have the potential to increase emissions by greater than the minimum quantities as specified in Appendix A of RIDEM APC Regulation No. 9, and, therefore, a minor source permit is **not** required for the *STRAP* implementation work.

6.0 PROPOSED AIR MONITORING ACTIVITIES DURING EARTHWORK

The air monitoring program for this *STRAP* was developed based on the results of the Estimated Air Emissions section 5.0 above, as well as the April 2011 *AQMP* and the May 2011 AQMP Follow-Up Correspondence with RIDEM, both included in Appendix D. The air monitoring program for this *STRAP* is consistent with previous air monitoring programs used for similar size/scope projects performed at the site.

6.01. FIELD INSTRUMENTS AND METHODOLOGY

During the proposed *STRAP* earthwork activities, real time air monitoring will be performed involving the use of the following hand held instrumentation.

- *Portable Photoionization Detector (PID) ppbRAE3000* – this instrument measures total volatile organic compounds (TVOC) with a detection limit of 1 parts per billion (ppb) or 0.001 parts per million (ppm). TVOC readings are measured every 10 seconds and an average is electronically logged every 3 minutes.
- *DustTRAK Dust Meter* – this dust meter uses infrared electromagnetic radiation to sense airborne particles less than 10 microns in size. The detection limit for this instrument is 1 $\mu g/m^3$. Similar to the PID, the readings from this hand held instrument are measured every 10 seconds and an average is electronically logged every 3 minutes.
- *A portable field gas chromatograph (Photovac Voyager)* – this instrument is used to monitor real time benzene concentrations in the field. The detection limit for benzene is 10 ppb (0.01 ppm). The Photovac Voyager collects and electronically records a measurement approximately every three minutes.

Hand held portable field equipment was determined to be appropriate for the *STRAP* based on the limited scope of the earthwork and short duration of this project. In addition, the use of hand held field equipment allows field personnel to alter monitoring locations based on the activity being performed and changing wind directions.

The readings from these hand held instruments are displayed in real time on the units and monitored by GZA's field personnel. The data is also electronically logged on each unit and available for download at the end of the work day. As the field personnel move the instruments from monitoring location to location, the time is recorded to aid in correlating the downloaded data to each monitoring location. In addition, periodic real time measurements are also hand recorded by field personnel.

During activities which involve earthwork, hand held readings will be collected both within the work area itself as well as at certain pre-designated locations along the work area perimeter (known herein as perimeter locations). Refer to attached Figure 8 (*Air Quality Monitoring Plan*) for approximate perimeter locations (W1 through W4). These perimeter locations were selected based on nearby receptors (i.e., Varieur School, Max Read Field and nearby residential properties). Field personnel will select the appropriate monitoring location reading depending on activities being performed and wind direction. During the course of an 8-hour work day, readings will be collected a minimum of 4 times per day at the four perimeter locations (W1 through W4). Readings at these perimeter locations will be collected over a minimum period of 6 minutes. The majority of the real-time air monitoring will be focused on the work area. In the event elevated levels are observed within the work area which indicate the work area threshold levels are being approached (sustained TVOC levels of 1.0 ppm, sustained benzene levels of 0.1 ppm, or sustained particulate levels of 1,000 µg/m^3), GZA field personnel will proceed to collect monitoring data at the closest perimeter location.

6.02. THRESHOLD LEVELS/RESPONSE ACTIONS

The following table presents the real-time monitoring threshold levels for the work area and perimeter locations. Figure 8 shows approximate perimeter locations (W1 through W4) that will be monitored during the earthwork. Note, as shown on Figure 8, these monitoring locations are conservatively situated proximate to the Work Area perimeter.

Real Time Monitoring – Action Levels		
Compound	**Work Area**	**Perimeter** (W1, W2, W3, and W4)
Total Volatile Organic Compounds (TVOC)	1.0 ppm	0.1 ppm
Respirable Particulate Dust (PM_{10})	1,000 µg/m^3	150 µg/m^3
Benzene	0.1 ppm	0.1 ppm

In the event these values are exceeded at sustainable levels within the work area or at the perimeter locations (*i.e.*, in excess of the respective threshold levels for a period of 5 minutes), GZA will identify the likely cause, and the Contractor shall implement appropriate engineering controls and/or modify work practices. The following table presents the actions that will be undertaken if a sustained exceedance of either respirable dust or TVOC is encountered.

Compound	Immediate Actions in the Event of a Sustained Exceedance of Action Levels
Total Volatile Organic Compounds (TVOC) and Benzene	1. Evaluate the likely source of sustained readings (i.e. truck emissions, moisture in the area, off-Site source, actual work, etc.) 2. If determined that the source is the actual work, Contractor shall implement appropriate engineering controls and/or modify work practices to address exceedances. Engineering controls shall include covering of materials with polyethylene sheeting, application of foams, application of water, limiting trenching lengths, etc. 3. Submit summa canisters from both an upgradient and downgradient locations for laboratory analysis when the work day is complete.
Respirable Particulate Dust (PM_{10})	1. Evaluate the source of sustained readings (i.e. earthwork, heavy wind, off-Site source, etc.) 2. If determined that the source is the actual work, Contractor shall implement appropriate engineering controls (e.g., application of water, calcium chloride, etc.) and/or modify work practices to address the exceedances.

The likely source of the sustained TVOC, benzene or particulate dust readings will be evaluated by Site personnel based field deductions using a combination of visual and/or olfactory evidence and real-time field measurements. By using hand-held field equipment, Site personnel can easily move these instruments from location to location to "track down" likely sources of emissions.

If determined that the source is the actual work, examples of engineered controls and/or modifications to work practices to address exceedances which may be implemented include application of water and/or calcium chloride to mitigate fugitive dust, and covering open trench excavations with plastic sheeting, and/or application of specially engineered foams to mitigate vapor emissions. These activities would be implemented within the limits of work.

As would be typical of any project at this Site, in the unlikely event that unexpected soil conditions are encountered, the Contractor will be directed to halt Site work and cordon off the area. The area will be stabilized and covered with plastic sheeting and work will not proceed until an appropriate course of action is determined based on the nature of materials encountered.

In addition to the above immediate response activities to exceedances of the threshold levels, in the event of a sustained exceedance of a perimeter threshold level at a perimeter monitoring locations (W1, W2, W3, or W4), National Grid will notify interested community members through a phone message alert system. This notification system will be implemented within approximately two hours of a sustained perimeter exceedance and will include information regarding the date/time of exceedance, nature of exceedance and field measures/work practice modifications implemented in response to the exceedance.

During air monitoring activities, GZA will make note of conditions which may be contributing to any observed transient TVOC levels both in the work area and at the perimeter locations. Several conditions and/or activities unrelated to actual emissions from the subsurface can result in PID readings in excess of 0.1 ppm including earthwork equipment and/or truck/vehicle exhaust, moisture/humidity levels, precipitation, dust/dirt accumulation and temperature. GZA will maintain a record of these types of local activities and/or conditions in our field reports along with corresponding, transient (less than 5 minute sustained) PID readings. Please note that given the extremely low threshold levels established for this project, there may be times when we cannot explain these transient occurrences.

6.03. TIME INTEGRATED LABORATORY SAMPLING

Time integrated air quality samples will be collected at the perimeter of the work area, at an upwind and a downwind location in order to document ambient levels of target VOCs using US EPA approved sampling and analytical methods. Two VOC samples, one upwind and one downwind, will be collected each day during all earthwork activities associated with the *STRAP*. VOC samples will only be submitted for analysis in the event of a sustained exceedance of the real time monitoring action levels (see above Section 6.02) for benzene or TVOCs is detected. The sampling locations will be chosen based on actual and predicted wind conditions for the sampling day. VOC samples will be collected using SUMMA stainless steel canisters in conjunction with US EPA Method TO-15 GC/MS Full Scan, as presented in "The Compendium of Methods for the Determination of Toxic Organic Compounds in the Ambient Air". The VOC samples will be analyzed for the compounds presented in the below table by an off-site certified laboratory. The SUMMA canister method consists of the collection of a whole air sample into an evacuated stainless steel canister. The canister is passively filled with sample air via a mass flow controller which allows for uniform filling of the canister over the eight hour sampling period. The laboratory results will be available 24 to 48 hours after collection. In addition, regardless of the results of the real-time monitoring, at least one set of time integrated samples will be collected during the *STRAP* activity.

Action Levels – Time Integrated Samples (Perimeter Locations (W1, W2, W3, and W4)		
Compound	**RIDEM AAL (24 hour)**	**Action Levels (24 hour average)**
Benzene	6.2 ppb	6.2 ppb
Toluene	80 ppb	80 ppb
Ethylbenzene	692 ppb	230 ppb
Xylenes	692 ppb	23 ppb
Naphthalene	0.6 ppb	20 ppb

In the event time integrated perimeter sampling results indicate levels in excess of the action levels above[3], the on-going activities will be shut down and engineered controls and work practices will be re-evaluated in consultation with RIDEM prior to re-initiating on-site work. As indicated below, these time integrated sampling results will be available 24-48 hours after collection.

7.0 OTHER PERMITS

All necessary permits will be obtained prior to the start of work. We currently anticipate that a Rhode Island Coastal Resource Management Council (CRMC) assent and RIDEM Water Quality Certification (WQC) will be required for the work, as described below:

- Based on the proximity of the proposed Project Area to the Seekonk River (both areas located within 200 feet of river bank), it is expected that an Assent application will be submitted to the CRMC for review and approval.
- The work includes repairing an existing discharge to the Seekonk River. The proposed drainage structures and drain line have been designed in accordance

[3] For a derivation of these action levels, please see the April 2011 *AQMP* included as Appendix D.

with the Rhode Island Stormwater Manual, last revised March 2015 and the RIDEM Water Quality Rules, last revised December 2009. A WQC will be submitted to the RIDEM Office of Water Resources for review and approval.

As indicated previously, RIDEM approval will be required prior to transporting any material from the City of Pawtucket Max Read Field project to the Tidewater Site.

8.0 PUBLIC INVOLVEMENT REQUIREMENTS

A finalized Public Involvement Plan (PIP) was submitted to RIDEM in October 2013 and is available on the Tidewater website (www.tidewatersite.com). The PIP is intended to be an agreement between National Grid and the public about how they will share information and how the public will be able to comment on plans for assessment and cleanup of the Site. As described previously, the requirements of the PIP will be followed as part of these *STRAP* activities.

The PIP consists of four basic components: public notice, fact sheets and enhanced communications, community meetings and information repositories. National Grid will carry out the following PIP activities as part of this *STRAP*:

- Prior to *STRAP* implementation:
  - Prepare a *STRAP*. National Grid has prepared this document to provide a summary of the background of *STRAP* activities, proposed response activities, public involvement requirements, estimated air emissions and air monitoring requirements and the proposed schedule. National Grid will submit this document to RIDEM for review. The *STRAP* will also be disseminated to the Tidewater Site mailing list, email list, websites and other information repositories, as outlined in the PIP.
  - Prepare an Abutter Notification and Project-specific Fact Sheet. This notification and fact sheet will have a description of the *STRAP* activities, proposed air monitoring activities, the proposed schedule and contact information. The fact sheet will be provided in English, Spanish and Portuguese, with a translation header in multiple languages stating: "This is an important notice. Please have it translated." The notification and fact sheet will be disseminated to the Tidewater Site mailing list, email list, websites, bulletin boards and other information repositories, as outlined in the PIP. It is anticipated that this abutter notification and fact sheet will be distributed at least 14 days prior to the public meeting (see below) and will include the date and time of the public meeting.
  - Host Public Meeting. National Grid will host a public meeting to present the proposed *STRAP* activities. We currently anticipate this community

meeting will be held at the Francis J. Varieur Elementary School, located at 486 Pleasant Street in Pawtucket, Rhode Island. Translation assistance will be provided for non-English speaking individuals, upon request. National Grid will submit a written summary of the meeting to RIDEM in hard copy and electronic format within 20 days of the meeting. The meeting summary will include identification of the main issues of concern, document requests by the public and proposed responses. The meeting summary will be disseminated to the Tidewater Site email list, websites, bulletin boards and other information repositories, as outlined in the PIP.

- *During STRAP* implementation:
    - Provide Daily Updates. On a daily basis during earthwork associated with the *STRAP* activities, a color coded system for the bulletin boards and website will be used to indicate whether active earth disturbing activities are occurring.
    - Provide Timely Air Monitoring Results. National Grid will provide results of air monitoring in a timely manner. During active earth disturbing activities, on a weekly basis, National Grid will post all air monitoring results on the bulletin boards and website. National Grid has also established a phone message network to distribute time-sensitive information to interested parties.
    - Provide RIDEM Weekly Updates. National Grid will provide weekly updates about the *STRAP* activities to RIDEM. The weekly updates will include a summary of air monitoring activities and a status of *STRAP* schedule. The weekly update will be posted on the bulletin boards and website.

- After finishing *STRAP* activities:
    - Prepare the STRA Closure Report. National Grid will prepare a document to provide a summary of the response activities, public involvement activity, and air monitoring results. National Grid will submit this document to RIDEM no more than 60 days following the STRA implementation. Additionally, National Grid will prepare a simple executive summary to act as the cover sheet of the STRA Closure Report. The executive summary will be provided in English, Spanish and Portuguese, with a translation header in multiple languages stating: "This is an important notice. Please have it translated." The STRA Closure Report will be disseminated to the Tidewater Site mailing list, email list, websites and other information repositories, as outlined in the PIP.

9.0 PROPOSED SCHEDULE

The schedule for implementation of the remedy described herein will depend on receipt of the *STRAP* Approval from RIDEM, receipt of other necessary permits and the PIP process. As described previously, we understand that the City of Pawtucket Max Read Field project is currently scheduled for implementation in the summer of 2016. Depending on timing of each, there may be advantages to performing these projects concurrently. National Grid is also prepared to perform these *STRAP* activities independent of the City's project. In either case, the current plan is to perform the work described herein during the summer of 2016.

Given the limited scope of this effort, we anticipated the implementation of the STRAP activities described herein can be completed in 3 to 4 weeks.

\\GZAProv1\Jobs\ENV\43654.msk\WORK\Max Read Field RFP\South washout - new submittal\STRAP\43654 South Washout Area STRAP 1-25-16 final.docx

FIGURES

DRAINAGE IMPROVEMENTS FOR THE SOUTH WASHOUT AREA
FORMER TIDEWATER FACILITY
PAWTUCKET, RHODE ISLAND

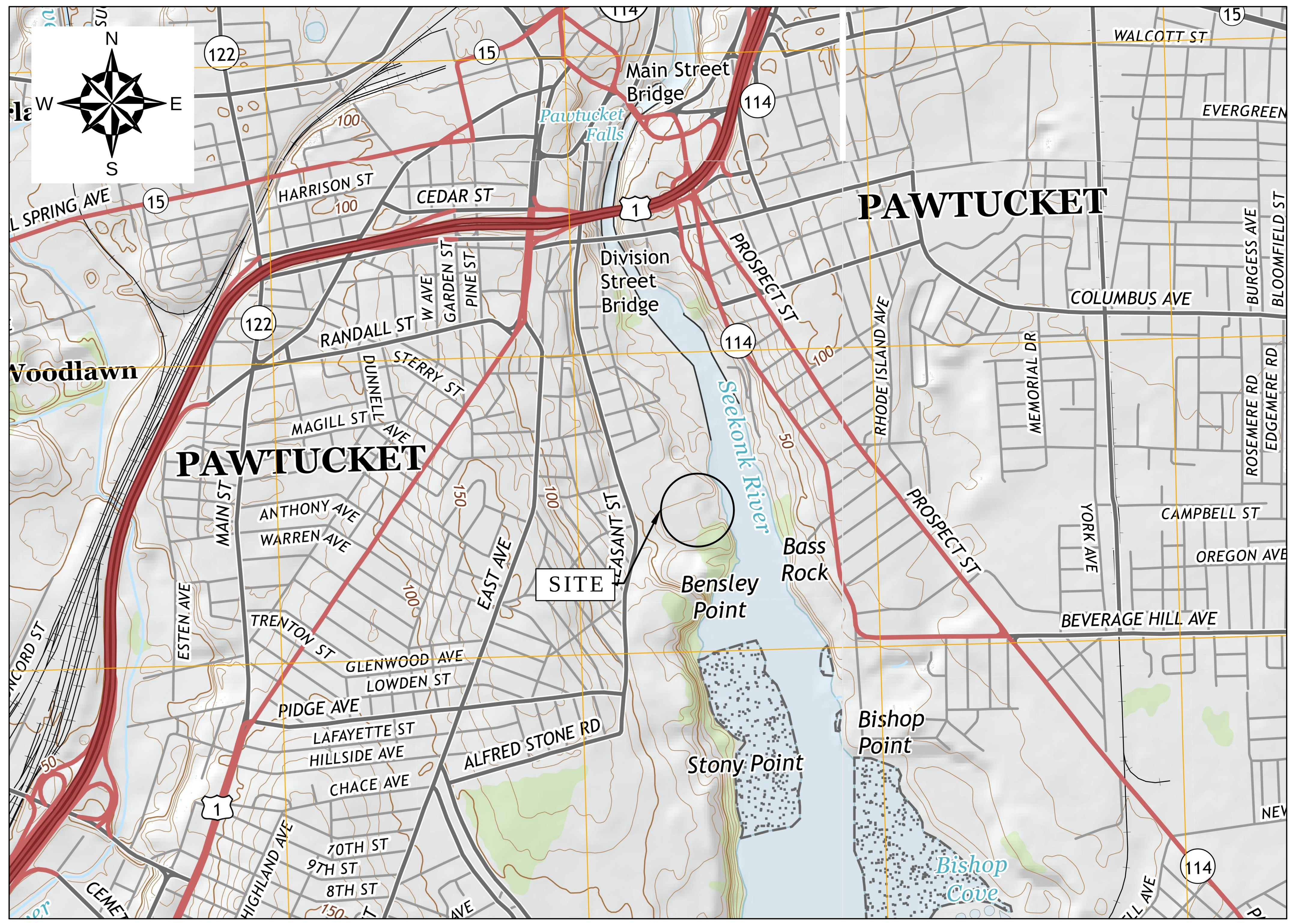
JANUARY 2016

PREPARED FOR:

nationalgrid

PREPARED BY:

GZA
GeoEnvironmental, Inc.
Engineers and Scientists
530 Broadway
Providence, Rhode Island 02909



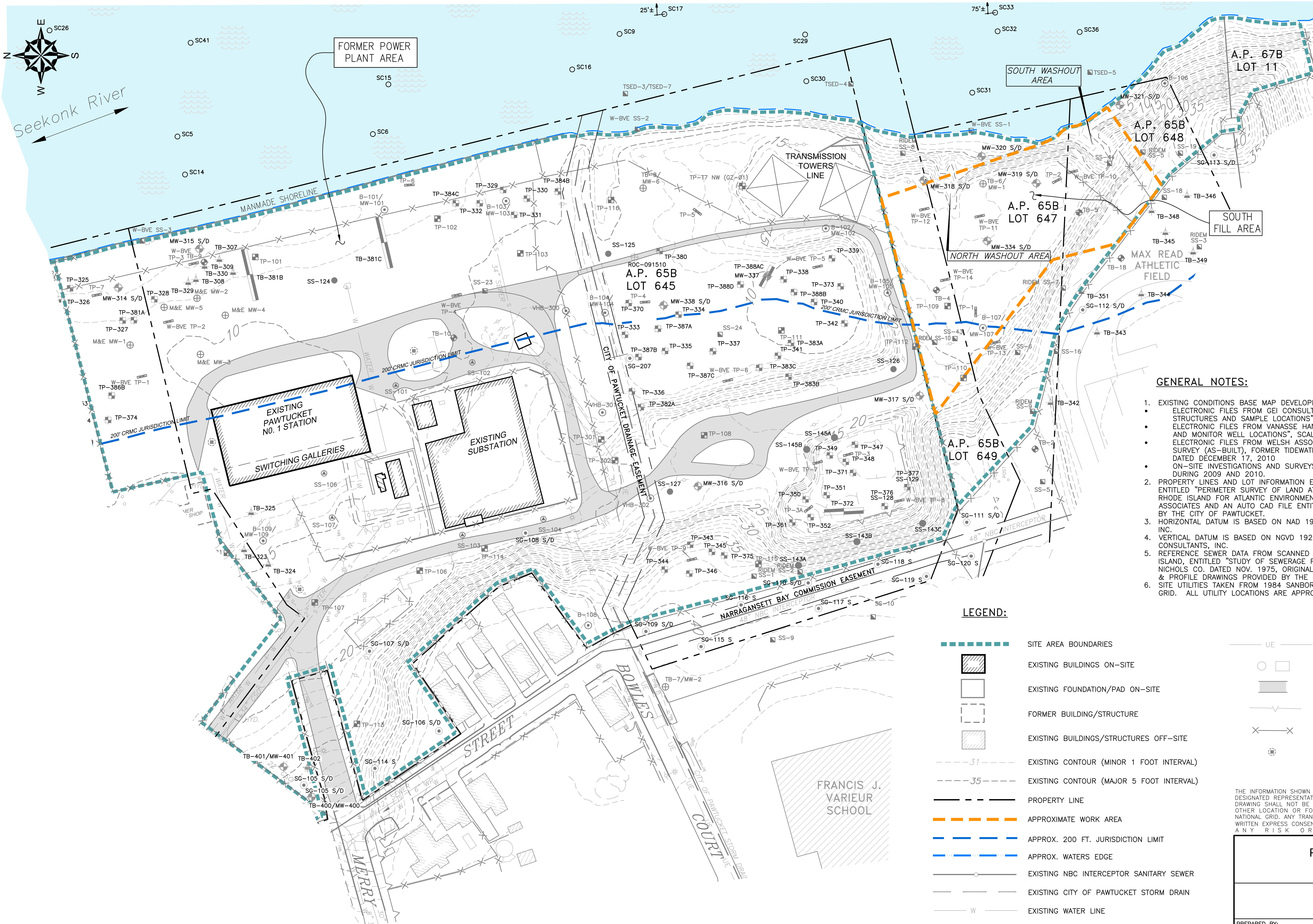
PROJECT LOCUS MAP

SOURCE: USGSSTORE.GOV

0 500' 1000' 2000' 3000'
SCALE IN FEET

INDEX OF DRAWINGS

PERMITTING SET
NOT FOR CONSTRUCTION



SCALE IN FEET 0 25 50 100 150

SAMPLE LEGEND

SS-9	ATLANTIC SURFACE SOIL SAMPLE LOCATION
TSED-6	ATLANTIC SEDIMENT SAMPLE LOCATION
W-BVE SS-3	WESTON/BLACKSTONE VALLEY ELECTRIC SEDIMENT SAMPLE LOCATION
RIDEM SS-3	RIDEM SURFACE SOIL SAMPLE LOCATION
B-109/MW-109	MONITORING WELL/BORING (VHB) SURVEYED
TP-3A	ATLANTIC TEST PIT LOCATION
W-BVE	WESTON/BLACKSTONE VALLEY ELECTRIC TEST PIT LOCATION
GZA TP-8	GZA/VALLEY GAS TEST PIT LOCATION
TB-15	ATLANTIC SOIL BORING LOCATION
MW-3	ATLANTIC MONITORING WELL LOCATION
M&E MW-1	METCALF & EDDY MONITORING WELL LOCATION
VHB-400	VHB SURFACE SOIL SAMPLE LOCATION NON-SURVEYED
TP-204	VHB TEST PIT (2006)
GZ-01	GZA TEST PIT (2009)
TB-300	GZA TEST BORING LOCATION (2010-2011)
MW-320 S/D	GZA MONITORING WELL LOCATION (2010-2011)
TP-306	GZA TEST PIT LOCATION (2010)
SS-100	GZA SURFACE SOIL SAMPLE LOCATION (2010)
SC31	ARCADIS SEDIMENT SAMPLE LOCATION (2008)
PIPE-1-061610	GZA RESIDUAL MATERIAL SAMPLE (2010)
SG-200	INTERIOR SOIL GAS SAMPLING LOCATION
SG-100	PERIMETER SOIL GAS SAMPLING LOCATION
TB-400	GZA BORING LOCATION (2014)
MW-400	GZA MONITORING WELL LOCATION (2014)

GENERAL NOTES:

1. EXISTING CONDITIONS BASE MAP DEVELOPED FROM THE FOLLOWING:
   - ELECTRONIC FILES FROM GEI CONSULTANTS, INC. (FORMERLY AES) ENTITLED "HISTORIC STRUCTURES AND SAMPLE LOCATIONS", ORIGINAL SCALE 1"=80', DATED JULY 1999
   - ELECTRONIC FILES FROM VANASSE HANGEN BRUSTLIN, INC. ENTITLED "SOIL BORING, TEST PIT AND MONITOR WELL LOCATIONS", SCALE: 1"=60', UNDATED
   - ELECTRONIC FILES FROM WELSH ASSOCIATES LAND SURVEYORS, INC. ENTITLED "TOPOGRAPHIC SURVEY (AS-BUILT), FORMER TIDEWATER FACILITY, DEMOLITION OF GAS HOLDERS NOS. 7 & 8", DATED DECEMBER 17, 2010
   - ON-SITE INVESTIGATIONS AND SURVEYS BY GZA PERSONNEL DURING VARIOUS SITE VISITS DURING 2009 AND 2010.
2. PROPERTY LINES AND LOT INFORMATION ESTABLISHED FROM INFORMATION PROVIDED ON A DRAWING ENTITLED "PERIMETER SURVEY OF LAND AT THE TIDEWATER FORMER MGP SITE IN PAWTUCKET, RHODE ISLAND FOR ATLANTIC ENVIRONMENTAL SERVICES INC." DEVELOPED BY LOUIS FEDERICI AND ASSOCIATES AND AN AUTO CAD FILE ENTITLED "MAX READ FIELD TRACK EXPANSION 2007" PROVIDED BY THE CITY OF PAWTUCKET.
3. HORIZONTAL DATUM IS BASED ON NAD 1983 FROM BASE MAPPING PROVIDED BY GEI CONSULTANTS, INC.
4. VERTICAL DATUM IS BASED ON NGVD 1929 (MSL) FROM BASE MAPPING PROVIDED BY GEI CONSULTANTS, INC.
5. REFERENCE SEWER DATA FROM SCANNED IMAGE PROVIDED BY THE CITY OF PAWTUCKET, RHODE ISLAND, ENTITLED "STUDY OF SEWERAGE FACILITIES" BY WATERMAN ENGINEERING CO. & ANDERSON NICHOLS CO. DATED NOV. 1975, ORIGINAL SCALE 1"=400' & SCANNED IMAGES OF HISTORIC PLAN & PROFILE DRAWINGS PROVIDED BY THE CITY OF PAWTUCKET, RHODE ISLAND.
6. SITE UTILITIES TAKEN FROM 1984 SANBORN MAP AND HISTORIC FIGURES PROVIDED BY NATIONAL GRID. ALL UTILITY LOCATIONS ARE APPROXIMATE AND SHOWN FOR REFERENCE ONLY.

LEGEND:

SITE AREA BOUNDARIES
EXISTING BUILDINGS ON-SITE
EXISTING FOUNDATION/PAD ON-SITE
FORMER BUILDING/STRUCTURE
EXISTING BUILDINGS/STRUCTURES OFF-SITE
EXISTING CONTOUR (MINOR 1 FOOT INTERVAL)
EXISTING CONTOUR (MAJOR 5 FOOT INTERVAL)
PROPERTY LINE
APPROXIMATE WORK AREA
APPROX. 200 FT. JURISDICTION LIMIT
APPROX. WATERS EDGE
EXISTING NBC INTERCEPTOR SANITARY SEWER
EXISTING CITY OF PAWTUCKET STORM DRAIN
EXISTING WATER LINE
EXISTING STORM/COMBINED SAN. SEWER OVERFLOW
EXISTING UNDERGROUND ELECTRIC CABLE IN CONDUIT
EXISTING UNDERGROUND ELECTRIC MH/STRUCTURE
EXISTING ACCESS ROAD
EXISTING RETAINING WALLS
EXISTING FENCE
EXISTING CATCH BASIN LOCATIONS

PERMITTING SET
NOT FOR CONSTRUCTION

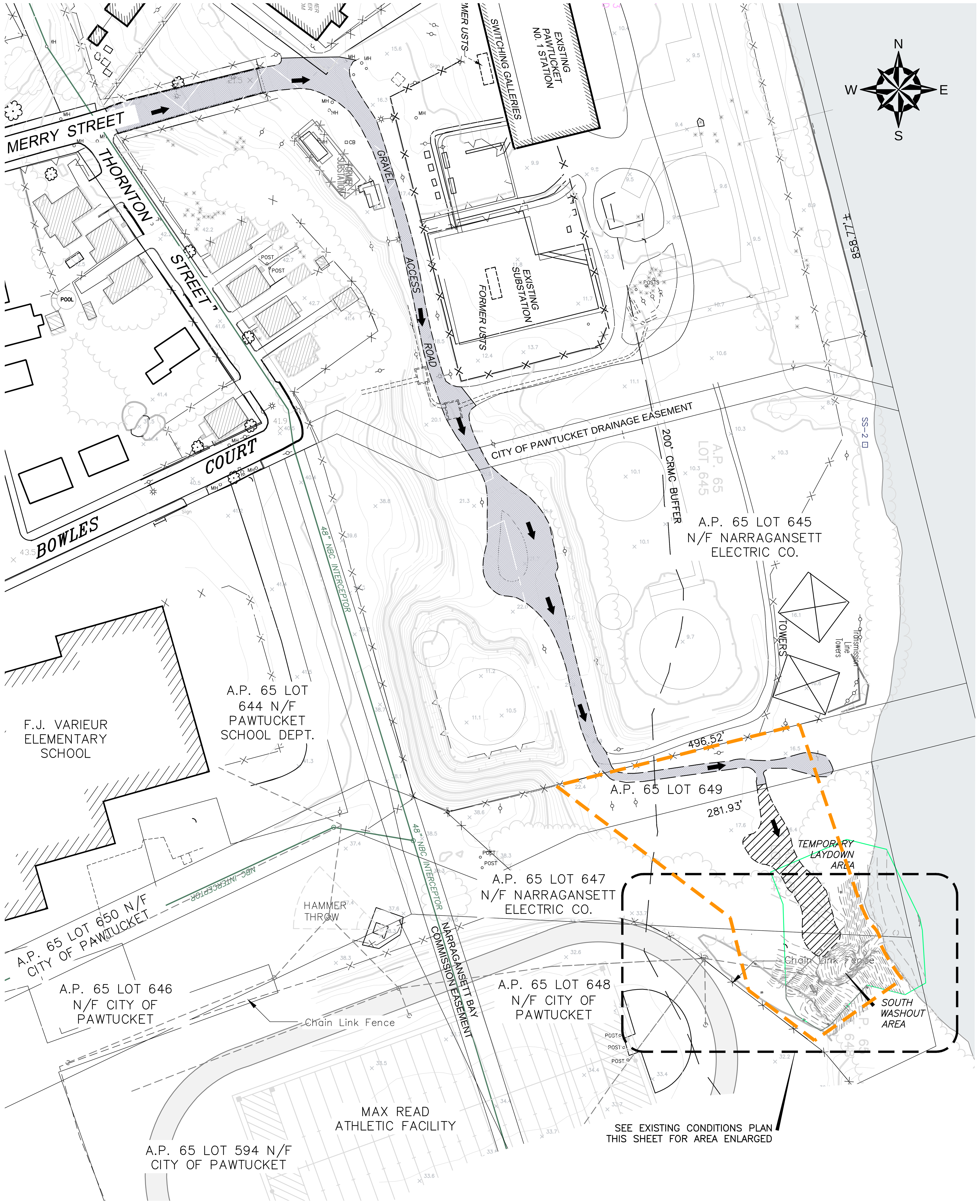
FORMER TIDEWATER FACILITY
PAWTUCKET, RHODE ISLAND

EXPLORATION LOCATION PLAN

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists
530 BROADWAY
PROVIDENCE, RHODE ISLAND 02909
(401) 421-4140

PREPARED FOR: nationalgrid

PROJ MGR: MSK	REVIEWED BY: JJC	CHECKED BY: JJC	FIGURE
DESIGNED BY: WF	DRAWN BY: CRD	SCALE: AS NOTED	2
DATE JANUARY 2016	PROJECT NO. 43654.00	REVISION NO. 0	SHEET NO. 2 OF 8



SITE CONSTRUCTION ACCESS PLAN

0 30 60 120 180
SCALE IN FEET

KEY:

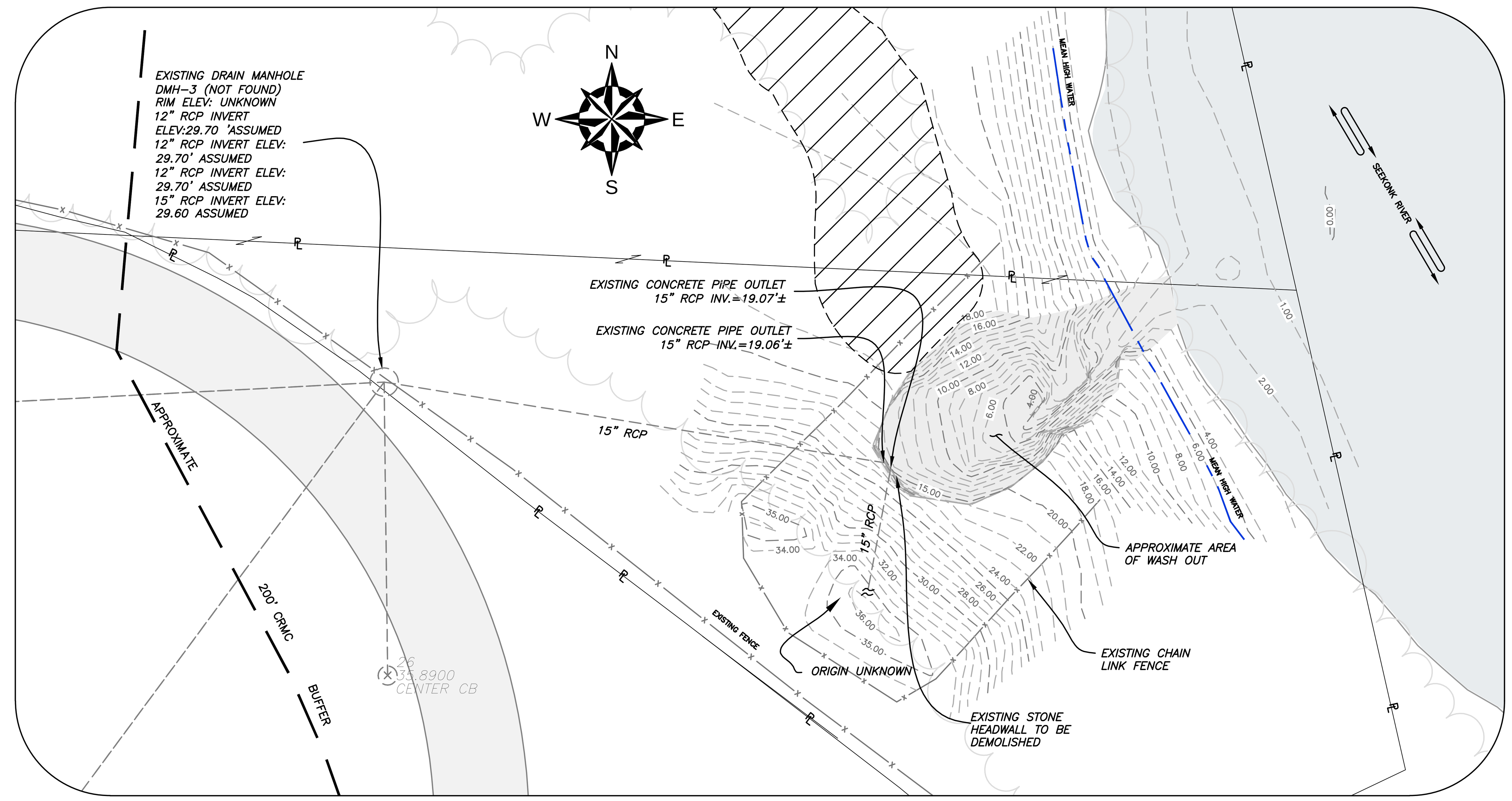
TEMPORARY CONSTRUCTION LAY DOWN AREA

CONSTRUCTION ACCESS TRAVEL DIRECTION (FROM MERRY STREET TO SOUTH WASHOUT AREA)

APPROXIMATE WORK AREA

GENERAL NOTES:

1. BASE MAP DEVELOPED FROM ELECTRONIC FILES FROM GEI CONSULTANTS, INC. ENTITLED "HISTORIC STRUCTURES AND SAMPLE LOCATIONS", ORIGINAL SCALE 1"=80', DATED JULY 1999 AND ELECTRONIC FILES FROM VANASSE HANGEN BRUSTLIN, INC. ENTITLED "SOIL BORING, TEST PITS AND MONITOR WELL LOCATION", SCALE: 1"=60'.
2. PROPERTY LINES AND LOT INFORMATION ESTABLISHED FROM INFORMATION PROVIDED ON A DRAWING ENTITLED "PERIMETER SURVEY OF LAND AT THE TIDEWATER FORMER MGP SITE IN PAWTUCKET, RHODE ISLAND FOR ATLANTIC ENVIRONMENTAL SERVICES INC." DEVELOPED BY LOUIS FEDERICI AND ASSOCIATES AND AN AUTO CAD FILE ENTITLED "MAX READ FIELD TRACK EXPANSION 2007" PROVIDED BY THE CITY OF PAWTUCKET.
3. HORIZONTAL DATUM IS BASED ON NAD 1983 FROM BASE MAPPING PROVIDED BY GEI CONSULTINGS, INC.
4. VERTICAL DATUM IS BASED ON NGVD 1929 (MSL) FROM BASE MAPPING PROVIDED BY GEI CONSULTINGS, INC.



EXISTING CONDITIONS PLAN

0 10 20 40 60
SCALE IN FEET

PERMITTING SET
NOT FOR CONSTRUCTION

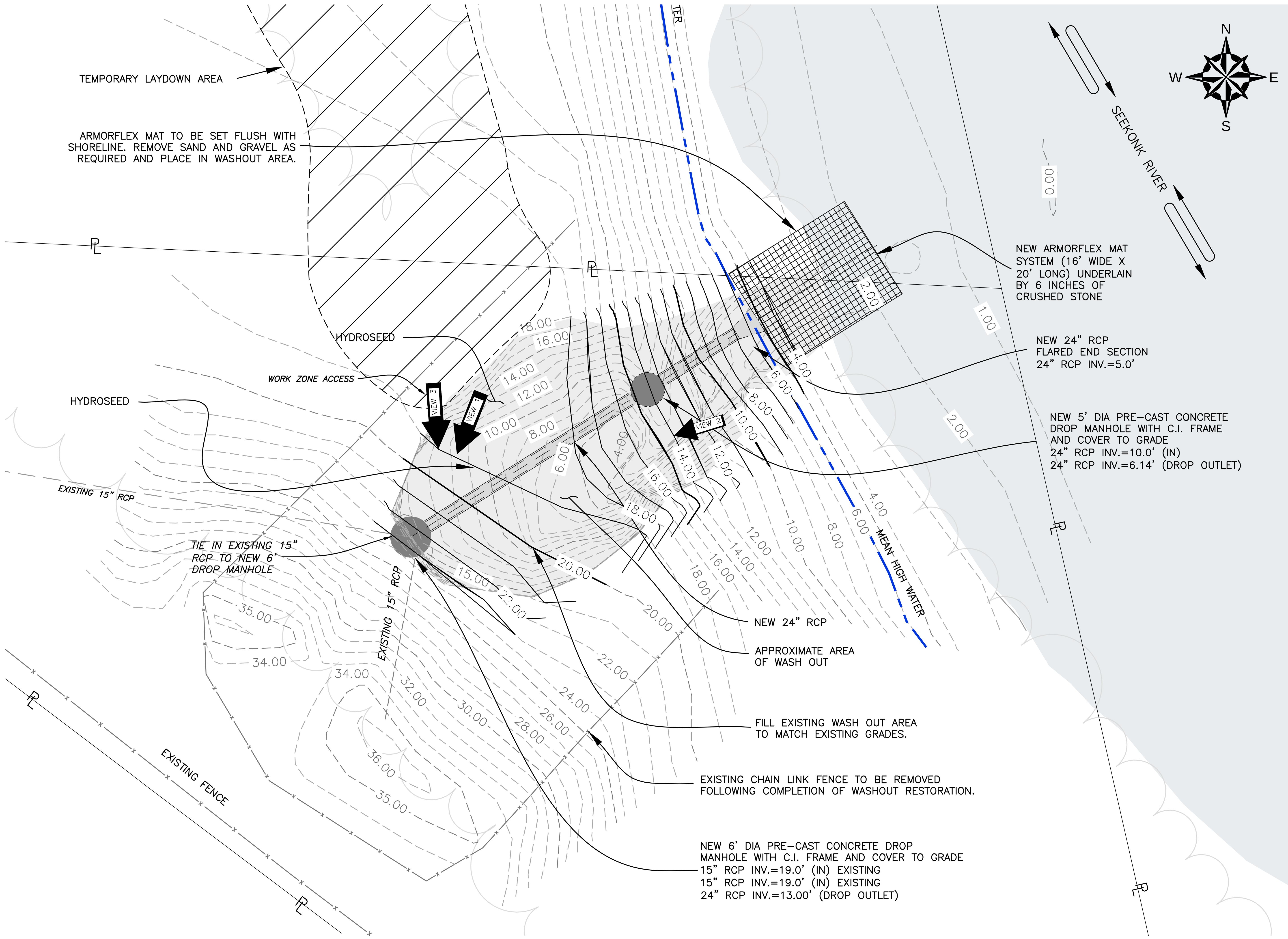
FORMER TIDEWATER FACILITY
PAWTUCKET, RHODE ISLAND

DRAINAGE IMPROVEMENTS
FOR THE SOUTH WASHOUT AREA
SITE CONSTRUCTION ACCESS PLAN & EXISTING CONDITIONS PLAN

PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
530 BROADWAY
PROVIDENCE, RHODE ISLAND 02909
(401) 421-4140

PREPARED FOR: nationalgrid

PROJ MGR: MSK	REVIEWED BY:	CHECKED BY: JJC	FIGURE 3
DESIGNED BY: TRG	DRAWN BY: NEF	SCALE: AS NOTED	
DATE JANUARY 2016	PROJECT NO. 43654.00	REVISION NO. 0	SHEET NO. 3 OF 8



PROPOSED CONDITIONS PLAN

GENERAL NOTES:

1. BASE MAP DEVELOPED FROM ELECTRONIC FILES FROM GEI CONSULTANTS, INC. ENTITLED "HISTORIC STRUCTURES AND SAMPLE LOCATIONS", ORIGINAL SCALE 1"=80', DATED JULY 1999 AND ELECTRONIC FILES FROM VANASSE HANGEN BRUSTLIN, INC. ENTITLED "SOIL BORING, TEST PITS AND MONITOR WELL LOCATION", SCALE: 1"=60'.
2. PROPERTY LINES AND LOT INFORMATION ESTABLISHED FROM INFORMATION PROVIDED ON A DRAWING ENTITLED "PERIMETER SURVEY OF LAND AT THE TIDEWATER FORMER MGP SITE IN PAWTUCKET, RHODE ISLAND FOR ATLANTIC ENVIRONMENTAL SERVICES INC." DEVELOPED BY LOUIS FEDERICI AND ASSOCIATES AND AN AUTO CAD FILE ENTITLED "MAX READ FIELD TRACK EXPANSION 2007" PROVIDED BY THE CITY OF PAWTUCKET.
3. HORIZONTAL DATUM IS BASED ON NAD 1983 FROM BASE MAPPING PROVIDED BY GEI CONSULTANTS, INC.
4. VERTICAL DATUM IS BASED ON NGVD 1929 (MSL) FROM BASE MAPPING PROVIDED BY GEI CONSULTANTS, INC.
5. ALL STORM DRAIN PIPE SHALL BE 24" DIAMETER REINFORCED CONCRETE PIPE.
6. EXCAVATED SOILS EXHIBITING IMPACTS WILL BE REUSED AS BACKFILL IN THE WASHOUT AREA IF GEOTECHNICALLY SUITABLE. UNSUITABLE MATERIAL WILL BE STOCKPILED AND DISPOSED OF OFF-SITE AT A NATIONAL GRID APPROVED FACILITY. ALL EXCAVATED SOILS TO BE STOCKPILED ON POLY SHEETING AND COVERED WITH POLY SHEETING.

KEY:

VIEW PHOTO NUMBER DIRECTION TAKEN

PERMITTING SET
NOT FOR CONSTRUCTION

0 5 10 20 30
SCALE IN FEET

VIEW #1 EXISTING HEADWALL
(PHOTO TAKEN FEB. 8, 2007)

VIEW #2 EXISTING HEADWALL & WASHOUT
(PHOTO TAKEN FEB. 8, 2007)

VIEW #3 EXISTING HEADWALL FROM TOP OF WASHOUT
(PHOTO TAKEN FEB. 8, 2007)

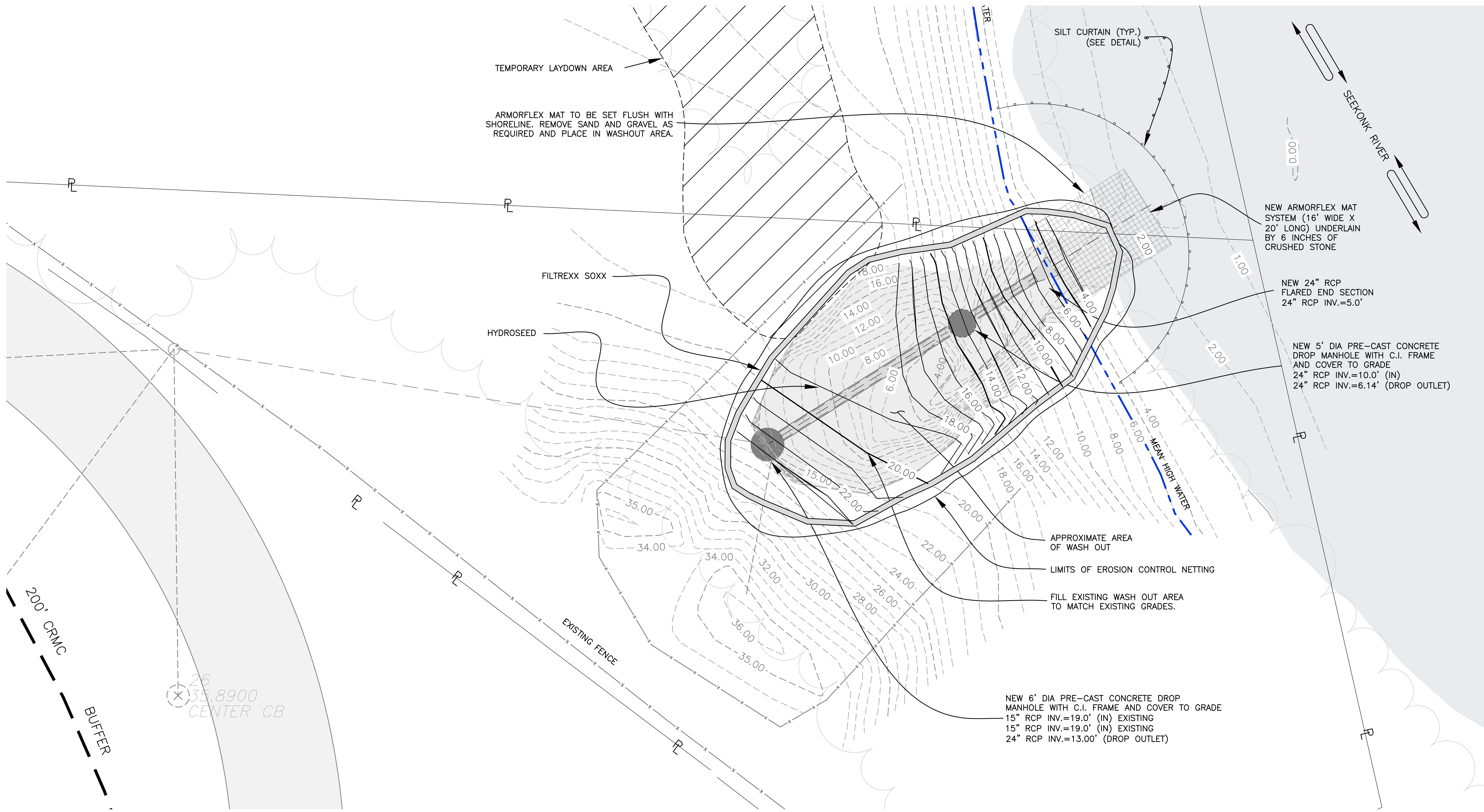
FORMER TIDEWATER FACILITY
PAWTUCKET, RHODE ISLAND

DRAINAGE IMPROVEMENTS
FOR THE SOUTH WASHOUT AREA
PROPOSED CONDITIONS PLAN

PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
530 BROADWAY JJC
PROVIDENCE, RHODE ISLAND 02909
(401) 421-4140

PREPARED FOR:
nationalgrid

PROJ MGR: MSK	REVIEWED BY: JJC	CHECKED BY: JJC	FIGURE 4
DESIGNED BY: TRG	DRAWN BY: NEF	SCALE: AS NOTED	
DATE JANUARY 2016	PROJECT NO. 43654.00	REVISION NO. 0	SHEET NO. 4 OF 8



EROSION CONTROL PLAN

SEDIMENTATION CONTROL PROGRAM:

1. FILTREXX SILTSOXX ARE TO BE INSTALLED PRIOR TO CONSTRUCTION AND SHALL BE MAINTAINED ON A REGULAR BASIS. IN ADDITION TO THE LINE OF SOCKS AT THE LIMIT OF CONSTRUCTION, TEMPORARY BARRIERS SHALL BE CONSTRUCTED AT THE TOE OF ALL DISTURBED (CUT OR FILL) SLOPES UNTIL VEGETATIVE COVER HAS BEEN ESTABLISHED.
2. SILT CURTAIN TO BE INSTALLED PRIOR TO INSTALLATION OF THE ARMOR FLEX MAT. SILT CURTAIN SHALL BE ANCHORED TO THE RIVER BOTTOM.
3. A SILT CURTAIN IS TO BE INSTALLED PRIOR TO CONSTRUCTION AND SHALL BE MAINTAINED ON A REGULAR BASIS.
4. CARE SHALL BE TAKEN NOT TO PLACE REMOVED SEDIMENTS WITHIN THE PATH OF THE EXISTING, NEWLY CREATED OR PROPOSED AREAS THAT ARE OR MAY BE SUBJECTED TO STORM WATER FLOW.
5. ALL DISTURBED AREAS THAT ARE SUBJECT TO EROSION, EITHER NEWLY FILLED OR EXCAVATED ARE TO BE PROTECTED. ACCEPTABLE METHODS OF PROTECTION ARE STONE RIP RAP OR SEEDING WITH FIBER MULCH PROTECTION.
6. DURING CONSTRUCTION THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING ADEQUATE DRAINAGE FLOW INCLUDING BYPASS PUMPING DURING STORMS AND PERIODS OF RAINFALL.
7. CONTRACTOR SHALL BE RESPONSIBLE FOR STORM WATER BYPASS FLOW EXISTING DRAIN LINES DURING INSTALLATION OF NEW DRAINAGE STRUCTURES AND PIPING.
8. SEDIMENTATION CONTROL DEVICES SHALL BE INSPECTED CLOSELY AND MAINTAINED PROMPTLY AFTER EACH RAINFALL.
9. ADDITIONAL SEDIMENT CONTROL MEASURES SHALL BE PLACED AS CONDITIONS WARRANT OR AS DIRECTED BY THE ENGINEER, SITE INSPECTOR, LOCAL OR STATE ENVIRONMENTAL OFFICIAL.

EROSION AND SOIL STABILIZATION PROGRAM:

1. TEMPORARY TREATMENTS SHALL CONSIST OF A HAY, STRAW, FIBER MULCH OR PROTECTIVE COVERS SUCH AS FABRIC MATS.
2. ALL TEMPORARY PROTECTION SHALL REMAIN IN PLACE UNTIL 85% GROWTH GRASS OR APPROVED GROUND COVER IS ESTABLISHED.
3. NORMAL ACCEPTABLE SEASONAL SEEDING DATES ARE APRIL 1ST THROUGH OCTOBER 15TH.
4. TOPSOIL SHALL HAVE A SANDY LOAM TEXTURE RELATIVELY FREE OF SUBSOIL MATERIAL, STONES, ROOTS, LUMPS, TREE LIMBS, TRASH OR DEBRIS AND SHALL CONFORM WITH RIDOT STANDARD SPECIFICATIONS.
5. THE SEED MIX SHALL BE INOCULATED WITHIN 24 HOURS OF APPLICATION WITH APPROPRIATE INOCULUM FOR EACH VARIETY. LIME AND FERTILIZER SHALL BE APPLIED TO UPGRADE EXISTING CONDITIONS AS NECESSARY. THE SEED MIX FOR OPEN NATURAL AREAS SHALL CONSIST OF 70% CREEPING RED FESCUE, 5% ASTORIA BENTGRASS, 15% BIRDSFOOT TREEFOIL, 10% PERENNIAL RYEGRASS AND SHALL BE APPLIED AT A RATE OF 100 POUNDS PER ACRE. LAWN AREAS SHALL BE SEEDED IN ACCORDANCE WITH SPECIFICATIONS.
6. THE CONTRACTOR MUST REPAIR AND/OR RESEED ANY AREAS THAT DO NOT DEVELOP WITHIN ONE YEAR OF PLANTING.
7. ALL FILL SHALL BE CLEAN AND THOROUGHLY COMPACTED UPON PLACEMENT IN CONFORMANCE WITH THE SPECIFICATIONS.
8. DENUDED SLOPES SHALL NOT REMAIN EXPOSED FOR MORE THAN 15 DAYS. SLOPES NOT PROTECTED BY SEEDING PRIOR TO OCTOBER 15TH SHALL BE PROTECTED USING OTHER TEMPORARY MEANS SUCH AS HAY, STRAW, FIBER MULCH, OR PROTECTIVE MATS OR BURLAP OR FIBERGLASS NETTING AS DIRECTED BY THE ENGINEER. THESE TEMPORARILY STABILIZED SLOPES SHALL BE SEEDED UPON COMMENCEMENT OF THE NEXT FOLLOWING PLANTING SEASON.
9. HAY AND STRAW APPLICATIONS SHALL BE IN THE AMOUNT OF 2000 POUNDS PER ACRE.

PERMITTING SET
NOT FOR CONSTRUCTION

N W E S

0 10 20 40 60
SCALE IN FEET

GENERAL NOTES:

1. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ESTABLISHING AND MAINTAINING ALL TEMPORARY SEDIMENTATION AND EROSION CONTROL.
2. EMBANKMENT SLOPES AND ALL DISTURBED AREAS ARE TO RECEIVE A 4" LAYER OF TOP SOIL AND SEED. PRIOR TO CLEARING, GRUBBING AND ROUGH GRADING, FILTREXX SILTSOXX SHALL BE PLACED AT THE LIMITS OF CONSTRUCTION.
3. ALL EROSION AND SEDIMENT CONTROL DEVICES SHALL BE MAINTAINED ON A REGULAR BASIS DURING CONSTRUCTION, AND PROMPTLY FOLLOWING STORMS OR PERIODS OF RAINFALL.

SLOPE STABILIZATION AND VEGETATION:

1. THE REMOVAL OF EXISTING VEGETATION IN THE SITE SHALL BE MINIMIZED.
2. A LINE OF FILTREXX SILTSOXX SHALL BE PLACED AT THE TOE OF ALL DISTURBED SLOPES AND MAINTAINED AS A SEDIMENT BARRIER UNTIL THE SLOPES ARE STABILIZED WITH GRASS.
3. VEGETATION REMOVED MAY BE SHREDDED AND CHIPPED ON SITE FOR USE AS MULCH, OR IT MAY BE REMOVED AND DISPOSED IN ANY LEGAL MANNER.
4. THE RESEEDING OF THE DISTURBED AREAS SHALL BE WITH SEED MATERIALS SELECTED FOR PRODUCTION OF A QUICK COVER AND HARDY STAND. THE SEEDING SHALL BE IN ACCORDANCE WITH COMMON NURSERY PRACTICE IN THE RHODE ISLAND AREA.
5. MULCH APPLICATIONS ON STEEP OR LONG SLOPES SHALL BE "CRIMPED" OR "TRACKED" TO PREVENT DISTURBANCE.
6. STOCKPILING OF SOILS SHALL NOT BE LOCATED NEAR WATERWAYS OR AREAS SUBJECT TO STORM FLOWAGE. STOCKPILES SHALL BE MAINTAINED WITH SIDE SLOPES LESS THAN 30%.

LANDSCAPE NOTES

1. THE CONTRACTOR SHALL PROVIDE 8" LOAM FOR ALL AREAS TO BE SEEDED. THE LANDSCAPE CONTRACTOR SHALL COORDINATE SUBGRADE PREPARATION WITH THE GENERAL CONTRACTOR PRIOR TO PLACING LOAM.
2. GROUNDCOVER MIX DESIGN: 1/3 MASS HIGHWAY SLOPEMIX (PERENNIAL 12 TO 24 INCHES HIGH); 1/3 PINTO WILDFLOWER (PERENNIAL WILDFLOWERS); 1/3 CROWN VETCH (PERENNIAL 12 TO 18 INCHES HIGH).
3. CONTRACTOR RESPONSIBLE FOR WATERING SEED O ENSURE ADEQUATE GROWTH.

LEGEND:

SILT CURTAIN
FILTREXX SILTSOXX AND SILT FENCE

NOTE:

FOR EROSION CONTROL DETAILS SEE SHEET NO. 7.

FORMER TIDEWATER FACILITY
PAWTUCKET, RHODE ISLAND

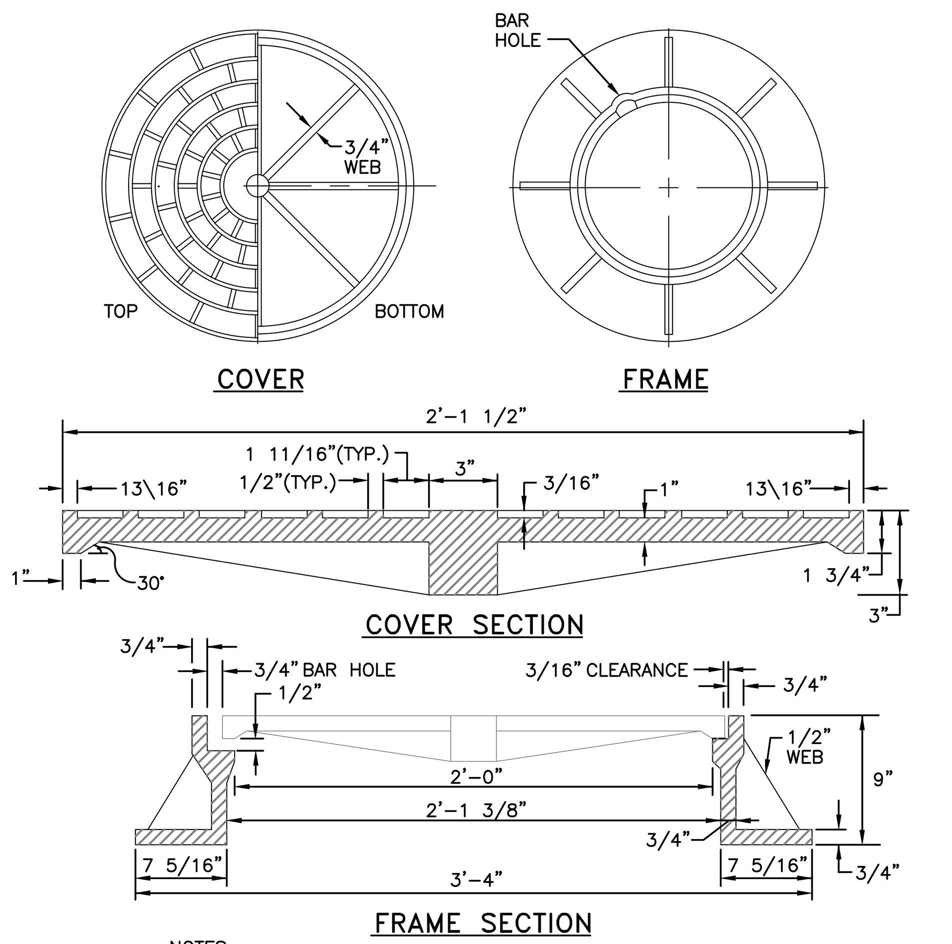
DRAINAGE IMPROVEMENTS
FOR THE SOUTH WASHOUT AREA
EROSION CONTROL PLAN

PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
530 BROADWAY
PROVIDENCE, RHODE ISLAND 02909
(401) 421-4140

PREPARED FOR:
nationalgrid

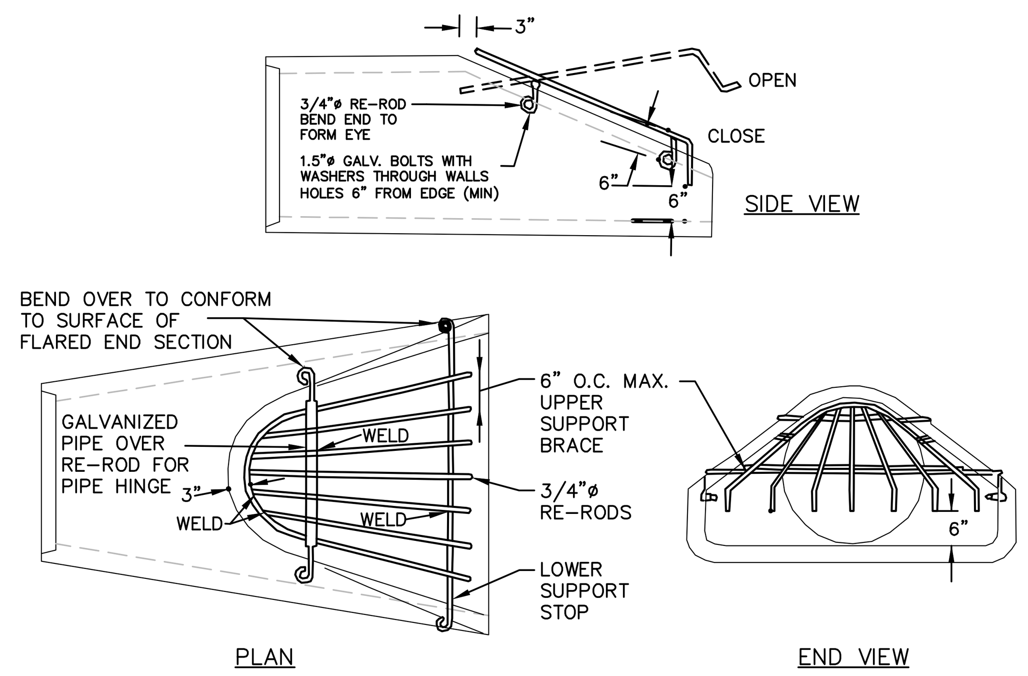
PROJ MGR: MSK	REVIEWED BY: JJC	CHECKED BY: JJC	FIGURE 5
DESIGNED BY: TRG	DRAWN BY: NEF	SCALE: AS NOTED	
DATE JANUARY 2016	PROJECT NO. 43654.00	REVISION NO. 0	SHEET NO. 5 OF 8

Saved Monday, January 25, 2016 9:05:03 AM LISA.THERIAULT Plotted Monday, January 25, 2016 9:05:29 AM Lisa Theriault



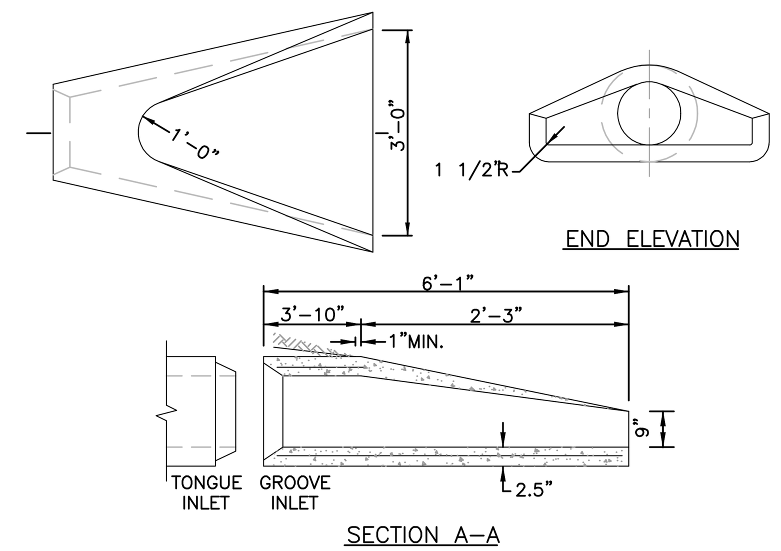
NOTES:
1. FRAME AND GRATE SHALL CONFORM TO SECTION M.04 OF THE R.I. STANDARD SPECIFICATIONS.
2. FRAME AND COVER SEATS MUST HAVE MACHINE FINISH.

HEAVY-DUTY ROUND FRAME AND COVER
NOT TO SCALE

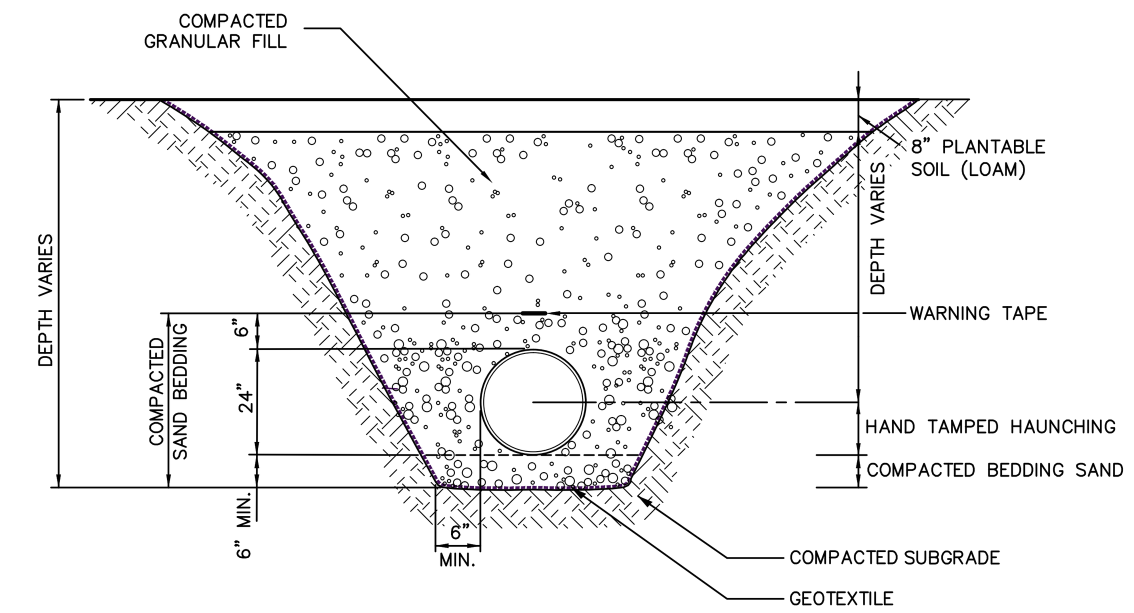


NOTES:
1. ALL RE-RODS ARE TO BE WELDED.
2. ALL RODS ARE TO BE GALVANIZED.

GRATING FOR FLARED END
NOT TO SCALE



PRECAST CONCRETE FLARED END SECTION
NOT TO SCALE



TYPICAL WASHOUT DETAIL
NOT TO SCALE

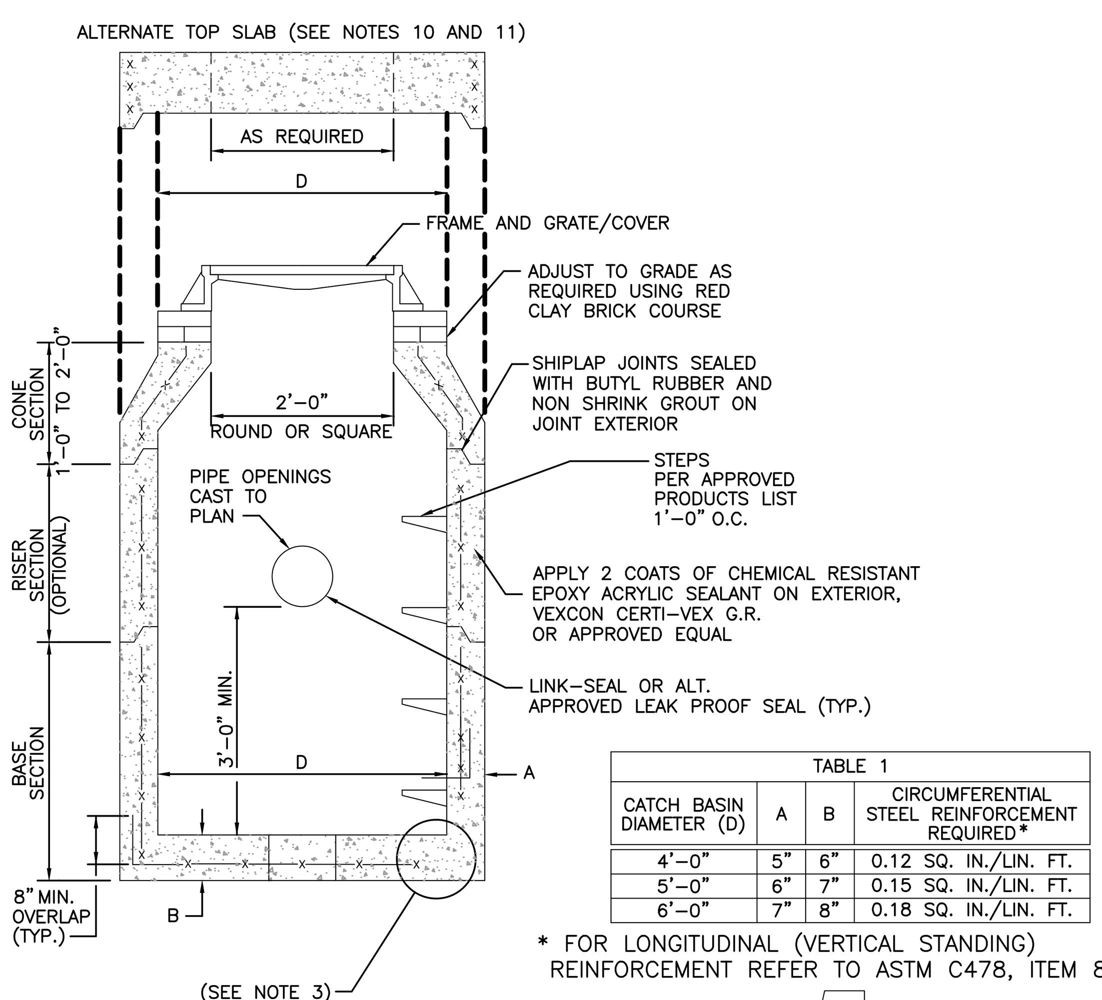
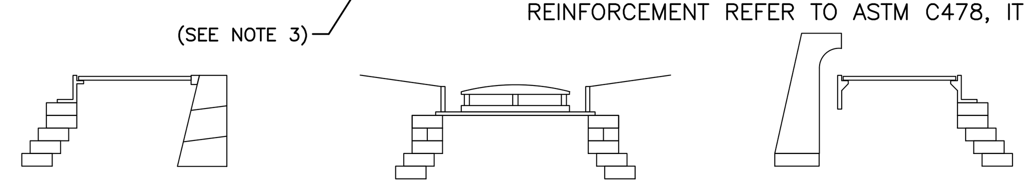


TABLE 1			
CATCH BASIN DIAMETER (D)	A	B	CIRCUMFERENTIAL STEEL REINFORCEMENT REQUIRED*
4'-0"	5"	6"	0.12 SQ. IN./LIN. FT.
5'-0"	6"	7"	0.15 SQ. IN./LIN. FT.
6'-0"	7"	8"	0.18 SQ. IN./LIN. FT.

* FOR LONGITUDINAL (VERTICAL STANDING) REINFORCEMENT REFER TO ASTM C478, ITEM 8.1.2

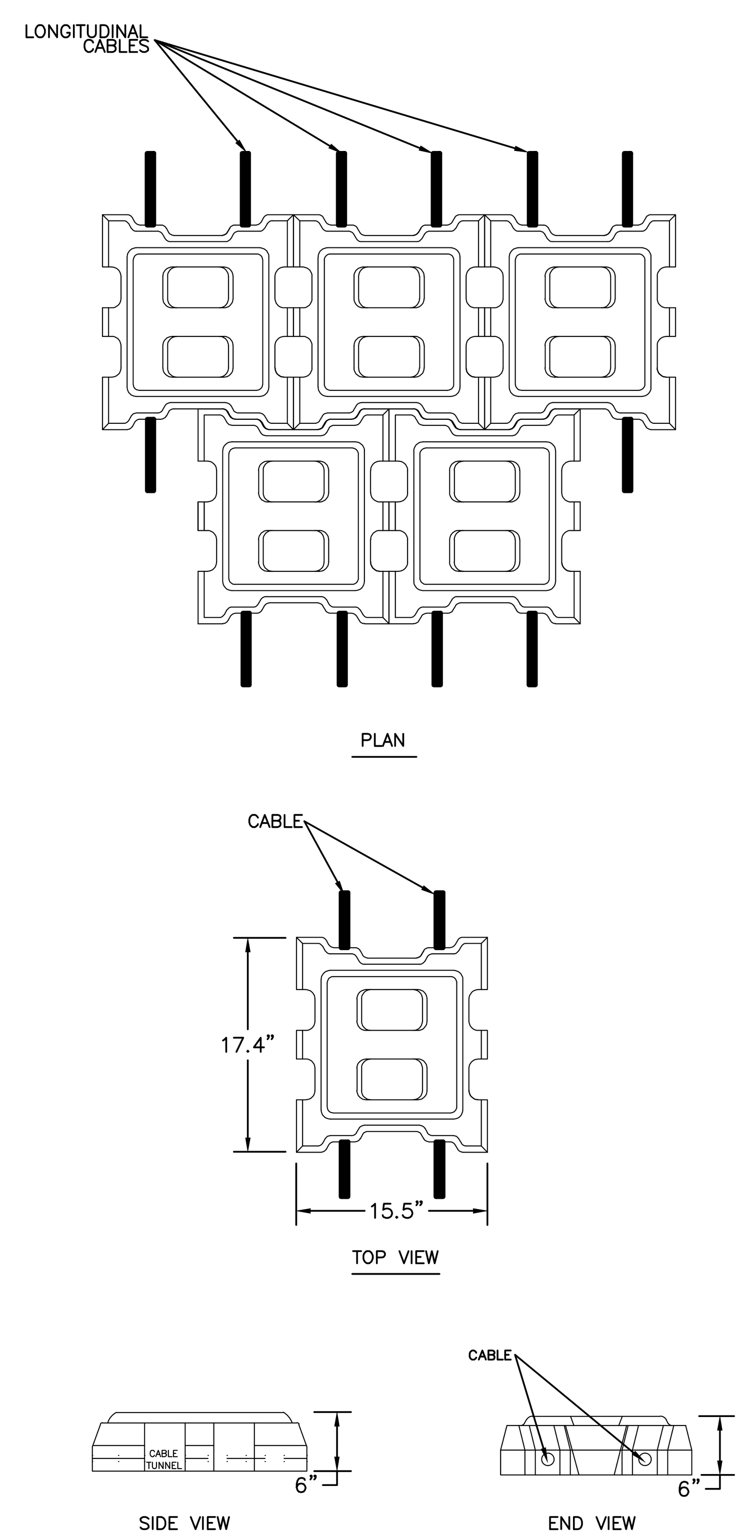


TYPE "D" TYPE "R" TYPE "F"

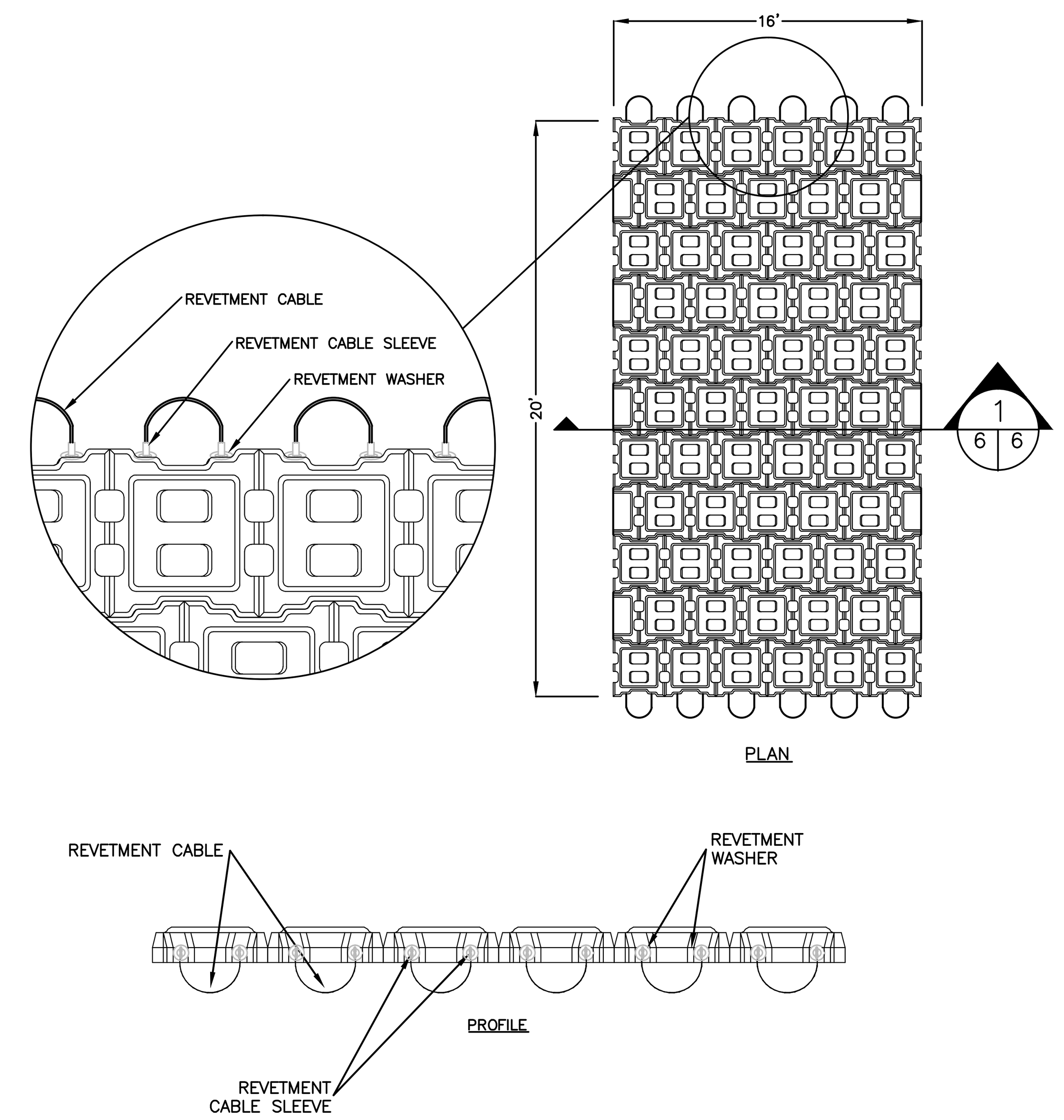
TYPE MANHOLE AS REQUIRED

NOTES:
1. SHALL BE IN ACCORDANCE WITH SECTION 702 OF THE R.I. STANDARD SPECIFICATIONS.
2. SEE TABLE 1 FOR STEEL REINFORCEMENT REQUIREMENTS.
3. STEEL REINFORCEMENT FOR BASE SECTION BOTTOM SHALL BE A MINIMUM OF 0.12 SQ. IN./LIN. FT. BOTH WAYS).
4. STEPS SHALL CONFORM TO STD. 5.3.0 AND SHALL BE INSTALLED AT THE CASTING PLANT.
5. ONE POUR MONOLITHIC BASE SECTION.
6. ANY NECESSARY ADJUSTMENTS DURING CONSTRUCTION WILL BE DONE BY SAW-CUTTING AND/OR CORING ONLY. NO JACKHAMMERS, HAMMERS AND CHISELS OR PNEUMATIC TOOLS WILL BE ALLOWED.
7. CORBEL MADE OF RED CLAY BRICK WILL BE PERMITTED FOR THE "CONE SECTION" OF THE CATCH BASIN ONLY.
8. FOR MANHOLE TYPES "D" AND "F" STEPS MUST BE INSTALLED ON THE CURB SIDE OF THE STRUCTURE.
9. THE CENTERLINE OF THE OPENING MUST BE WITHIN FROM THE STEPS.
10. ALTERNATE TOP SLAB IS STEEL REINFORCED TO MEET OR EXCEED H-25 LOADING (SEE STD. 4.7.2).
11. ALTERNATE TOP SLAB IS ONLY FOR USE WHEN REDUCING SECTION DOES NOT FIT BECAUSE OF STRUCTURE DEPTH.
12. REFER TO STD. 5.2.0 FOR MAXIMUM PIPE SIZES.
13. MANHOLE STRUCTURES SHALL BE VACUUM TESTED IN ACCORDANCE WITH ASTM C1244 DRAIN LINES SHALL BE TESTED BY A LOW PRESSURE AIR TEST IN ACCORDANCE WITH ASTM F1417

PRECAST 4'-0", 5'-0", OR 6'-0" ROUND MANHOLE
NOT TO SCALE

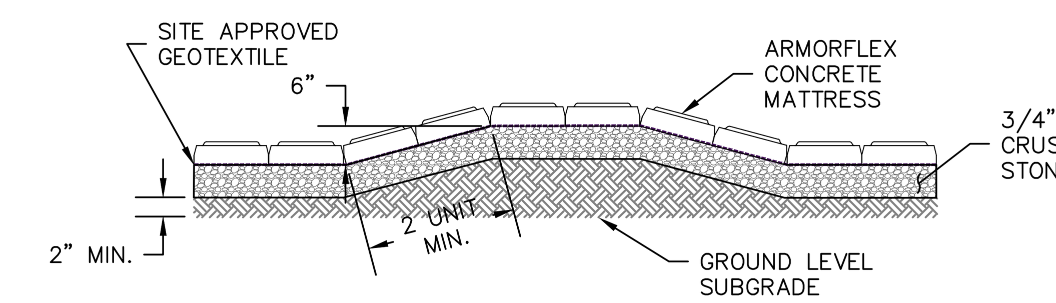


ARMORFLEX CLASS 50 STANDARD BLOCK DETAIL
NOT TO SCALE



NOTE:
INSTALL ARMORFLEX MATS FLUSH WITH EXISTING GRADE PER MANUFACTURER'S INSTRUCTIONS.

ARMORFLEX STANDARD DETAIL (STANDARD CLASS CELL MAT)
NOT TO SCALE



1/6 6 SECTION: ARMORFLEX AT WATERLINE (TYP.)
NOT TO SCALE

PERMITTING SET
NOT FOR CONSTRUCTION

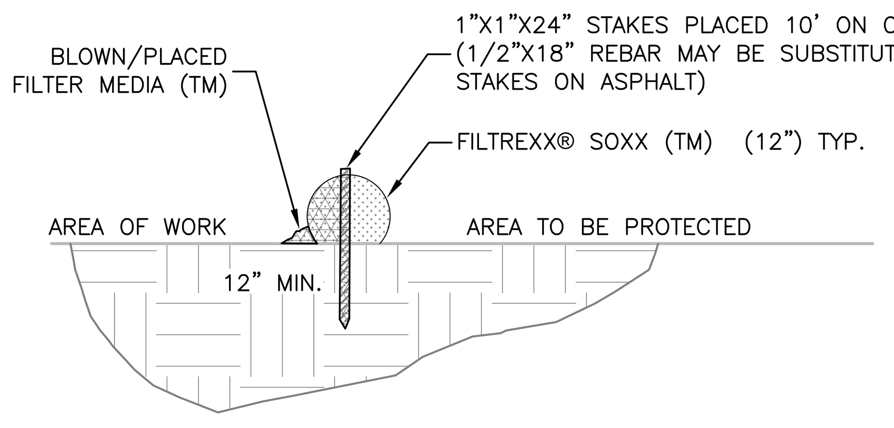
FORMER TIDEWATER FACILITY
PAWTUCKET, RHODE ISLAND

DRAINAGE IMPROVEMENTS
FOR THE SOUTH WASHOUT AREA
DETAILS (1 OF 2)

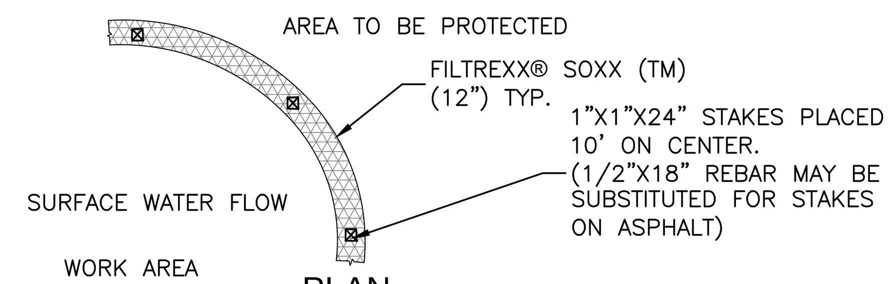
PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
530 BROADWAY
PROVIDENCE, RHODE ISLAND 02909
(401) 421-4140

PREPARED FOR:
nationalgrid

PROJ MGR: MSK	REVIEWED BY: JJC	CHECKED BY:	FIGURE 6
DESIGNED BY: TRG	DRAWN BY: NEF	SCALE: AS NOTED	
DATE JANUARY 2016	PROJECT NO. 43654.00	REVISION NO. 0	SHEET NO. 6 OF 8



SECTION
NTS

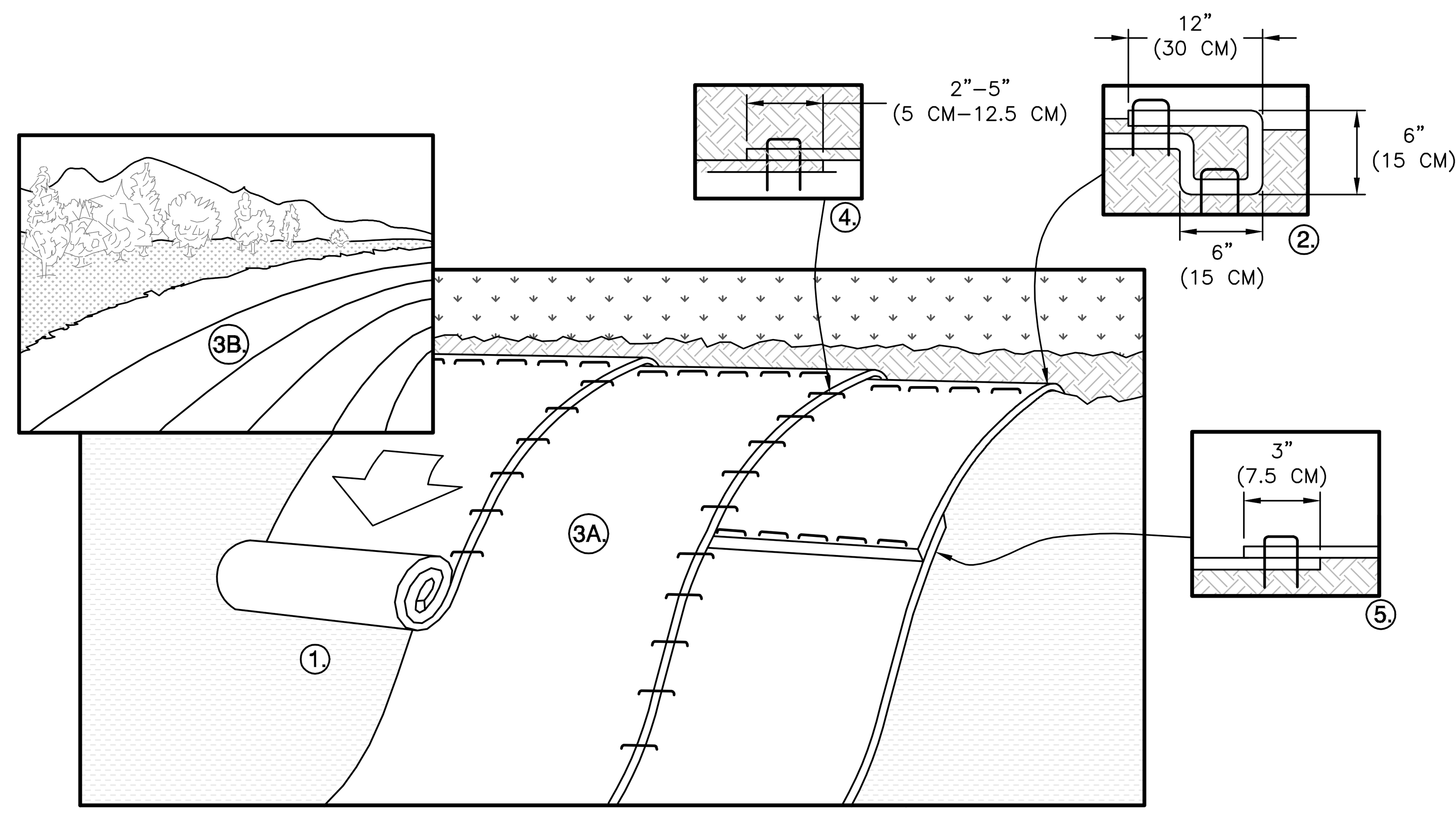


PLAN
NTS

NOTES:
1. ALL MATERIAL TO MEET FILTREXX® SPECIFICATIONS.
2. FILTER MEDIA (TM) FILL TO MEET APPLICATION REQUIREMENTS.
3. COMPOST MATERIAL TO BE DISPERSED ON SITE AS APPROVED BY ENGINEER.
4. STAKES/REBAR PINS SHALL HAVE PROTECTIVE CAPS INSTALLED TO PREVENT FALL INJURY.

FILTREXX® SOXX SEDIMENT CONTROL DETAIL

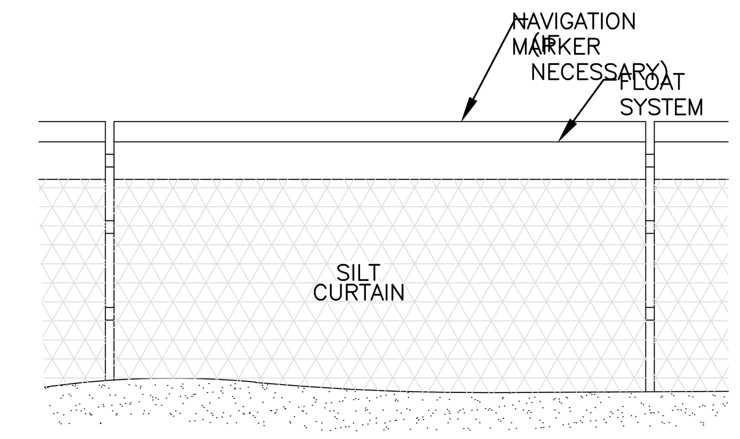
NOT TO SCALE



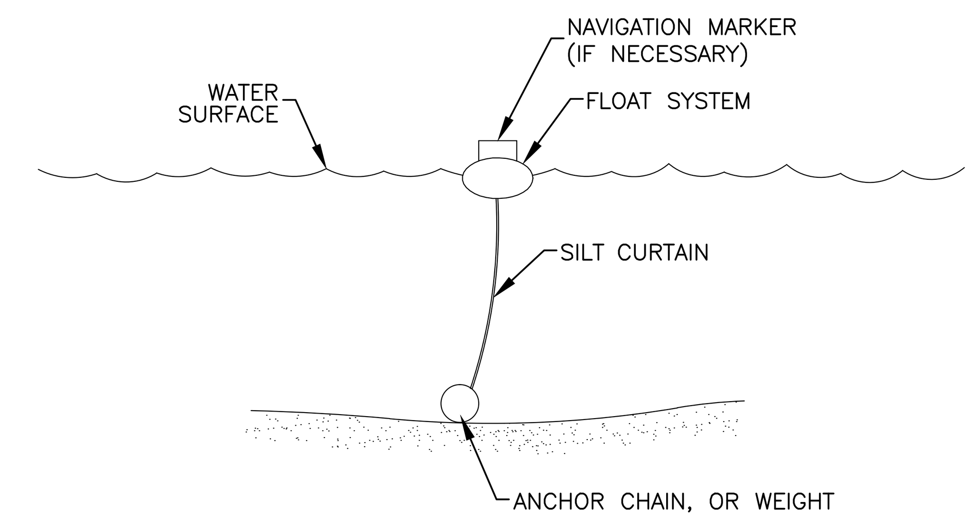
1. PREPARE SOIL BEFORE INSTALLING ROLLED EROSION CONTROL PRODUCTS (RECP'S), INCLUDING ANY NECESSARY APPLICATION OF LIME, FERTILIZER, AND SEED. (NOTE:WHEN USING CELL–O–SEED DO NOT SEED PREPARED AREA. CELL–O–SEED MUST BE INSTALLED WITH PAPER SIDE DOWN.)
2. BEGIN AT THE TOP OF THE SLOPE BY ANCHORING THE RECP'S IN A 6" (15 CM) WIDE TRENCH WITH APPROXIMATELY 12" (30 CM) OF RECP'S EXTENDED BEYOND THE UP–SLOPE PORTION OF THE TRENCH. ANCHOR THE RECP'S WITH A ROW OF STAPLES/STAKES APPROXIMATELY 12" (30 CM) APART IN THE BOTTOM OF THE TRENCH. BACKFILL AND COMPACT THE TRENCH AFTER STAPLING. APPLY SEED TO COMPACTED SOIL AND FOLD REMAINING 12" (30 CM) PORTION OF RECP'S BACK OVER SEED AND COMPACTED SOIL. SECURE RECP'S OVER COMPACTED SOIL WITH A ROW OF STAPLES/STAKES SPACED APPROXIMATELY 12" (30 CM) APART ACROSS THE WIDTH OF THE RECP'S.
3. ROLL THE RECP'S (A.) DOWN OR (B.) HORIZONTALLY ACROSS THE SLOPE. RECP'S WILL UNROLL WITH APPROPRIATE SIDE AGAINST THE SOIL SURFACE. ALL RECP'S MUST BE SECURELY FASTENED TO SOIL SURFACE BY PLACINGSTAPLES/STAKES IN APPROPRIATE LOCATIONS AS SHOWN IN THE STAPLE PATTERN GUIDE. WHEN USING THE DOT SYSTEM , STAPLES/STAKES SHOULD BE PLACED THROUGH EACH OF THE COLORED DOTS CORRESPONDING TO THE APPROPRIATE STAPLE/STAKE PATTERN.
4. THE EDGES OF PARALLEL RECP'S MUST BE STAPLED WITH APPROXIMATELY 2"–5" (5 CM–12.5 CM) OVERLAP DEPENDING ON RECP'S TYPE.
5. CONSECUTIVE RECP'S SPLICED DOWN THE SLOPE MUST BE PLACED END OVER END (SHINGLE STYLE) WITH AM APPROXIMATE 3" (7.5 CM) OVERLAP. STAPLE THROUGH OVERLAP AREA, APPROXIMATELY 12" (30 CM) APART ACROSS THE ENTIRE RECP'S WIDTH. (NOTE: IN LOOSE SOIL CONDITIONS, THE USE OF STAPLE OR STAKE LENGTHS OF OVERLAP GREATER THAN 6" (15 CM) MAY BE NECESSARY TO PROPERLY SECURE THE RECP'S.)

TEMPORARY EROSION CONTROL NETTING – TYPICAL SLOPE INSTALLATION DETAIL

NOT TO SCALE



FRONT VIEW



SIDE VIEW

NOTES:
1. THE HEIGHT OF THE CURTAIN SHALL BE 20% GREATER THAN WATER DEPTH.
2. TIE TOGETHER THROUGH GROMMETS USING APPROPRIATE TIES.
3. CURTAIN SHALL BE ANCHORED AS SPECIFIED BY MANUFACTURER.
4. NAVIGATIONAL MARKERS ARE RECOMMENDED.
5. REGULAR VISUAL INSPECTIONS ARE REQUIRED TO DETERMINE IF ALL COMPONENTS ARE FUNCTIONING PROPERLY.
6. ADJUSTMENTS MAY BE REQUIRED AS WATER ELEVATION CHANGES.
7. CONTRACTOR SHALL FOLLOW ALL GUIDELINES AS SPECIFIED BY MANUFACTURER CONCERNING ALL ASPECTS OF SILT CURTAIN USE, INCLUDING, BUT NOT LIMITED TO: ASSEMBLY, INSTALLATION, ANCHORING, MAINTENANCE, AND INSPECTION

SILT CURTAIN DETAIL

NOT TO SCALE

PERMITTING SET
NOT FOR CONSTRUCTION

FORMER TIDEWATER FACILITY
PAWTUCKET, RHODE ISLAND

DRAINAGE IMPROVEMENTS
FOR THE SOUTH WASHOUT AREA
DETAILS (2 OF 2)

PREPARED BY:
GZA GeoEnvironmental, Inc.
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(401) 421-4140

PREPARED FOR:
nationalgrid

PROJ MGR: MSK	REVIEWED BY: JJC	CHECKED BY: JJC	FIGURE 7
DESIGNED BY: TRG	DRAWN BY: NEF	SCALE: AS NOTED	
DATE JANUARY 2016	PROJECT NO. 43654.00	REVISION NO. 0	SHEET NO. 7 OF 8

Saved Monday, January 25, 2016 9:13:39 AM LISA.THERIAULT Plotted Monday, January 25, 2016 9:14:04 AM Lisa Theriault

LEGEND:

APPROXIMATE PROPERTY LINES

APPROXIMATE WORK AREA

TIDEWATER SITE BOUNDARY

W1 PERIMETER AIR QUALITY MONITORING LOCATION

REFERENCE NOTES:

1. THIS MAP CONTAINS THE ESRI ARCGIS ONLINE BING MAPS AERIAL LAYER PACKAGE. IMAGE COURTESY OF USGS EARTHSTAR GEOGRAPHICS SIO © MICROSOFT CORPORATION 2016.
2. PROPERTY LINES AND LOT INFORMATION ESTABLISHED FROM THE CITY OF PAWTUCKET ZONING MAP ADOPTED ON OCTOBER 21, 1966 AND AMENDED DECEMBER 19, 2003 AND INFORMATION PROVIDED ON AN AUTOCAD DRAWING TITLED "MAX READ FIELD TRACK EXPANSION 2007" PROVIDED BY THE CITY OF PAWTUCKET.

PERMITTING SET
NOT FOR CONSTRUCTION

0 25 50 100 150
SCALE IN FEET

N E S W

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FORMER TIDEWATER FACILITY

PAWTUCKET, RHODE ISLAND

AIR QUALITY MONITORING PLAN AERIAL IMAGE

PREPARED BY: GZA GeoEnvironmental, Inc. Engineers and Scientists 530 BROADWAY PROVIDENCE, RHODE ISLAND 02909 (401) 421-4140

PREPARED FOR: nationalgrid

PROJ MGR: MSK	REVIEWED BY:	CHECKED BY:	FIGURE 8
DESIGNED BY: TRG	DRAWN BY: LDT	SCALE: AS NOTED	
DATE JANUARY 2016	PROJECT NO. 43654.00	REVISION NO. 0	SHEET NO. 8 OF 8

APPENDIX A - LIMITATIONS

LIMITATIONS

1. This Short Term Response Action Plan has been prepared on behalf of and for the exclusive use of The Narragansett Electric Company d/b/a National Grid (National Grid), solely for use in documenting the work completed as described herein at the Former Tidewater MGP and Power Plant Site ("Site") under the applicable provisions of the State of Rhode Island Department of Environmental Management Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases (Remediation Regulations). This report and the findings contained herein shall not, in whole or in part, be disseminated or conveyed to any other party, nor used by any other party in whole or in part, without the prior written consent of GZA GeoEnvironmental, Inc.(GZA) or National Grid.

2. GZA's work was performed in accordance with generally accepted practices of other consultants undertaking similar studies at the same time and in the same geographical area, and GZA observed that degree of care and skill generally exercised by other consultants under similar circumstances and conditions. GZA's findings and conclusions must be considered not as scientific certainties, but rather as our professional opinion concerning the significance of the limited data gathered during the course of the study. No other warranty, express or implied is made. Specifically, GZA does not and cannot represent that the Site contains no hazardous material, oil, or other latent condition beyond that observed by GZA during the work described herein.

3. The observations described in this report were made under the conditions stated therein. The conclusions presented in the report were based upon services performed and observations made by GZA.

4. In the event that National Grid or others authorized to use this report obtain information on environmental or hazardous waste issues at the Site not contained in this report, such information shall be brought to GZA's attention forthwith. GZA will evaluate such information and, on the basis of this evaluation, may modify the conclusions stated in this report.

5. The conclusions and recommendations contained in this report are based in part upon the data obtained from environmental samples obtained from relatively widely spread subsurface explorations. The nature and extent of variations between these explorations may not become evident until further exploration. If variations or other latent conditions then appear evident, it will be necessary to reevaluate the conclusions and recommendations of this report.

6. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretations of widely spaced explorations and samples; actual soil transitions are probably more gradual. For specific information, refer to the boring logs.

7. In the event this work included the collection of water level data, these readings have been made in the test pits, borings and/or observation wells at times and under conditions stated on the exploration logs. These data have been reviewed and interpretations have been made in the text of this report. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall and other factors different from those prevailing at the time measurements were made.

8. The conclusions contained in this report are based in part upon various types of chemical data and are contingent upon their validity. These data have been reviewed and interpretations made in the report. Moreover, it should be noted that variations in the types and concentrations of contaminants and variations in their flow paths may occur due to seasonal water table fluctuations, past disposal practices, the passage of time, and other factors. Should additional chemical data become available in the future, these data should be reviewed by GZA and the conclusions and recommendations presented herein modified accordingly.

\\GZAProv1\Jobs\ENV\43654.msk\WORK\Max Read Field RFP\South washout - new submittal\STRAP\Appendices\Appendix A - Limitations\43654 Limitations-Appendix A.docx

APPENDIX B - PHOTOGRAPHS

12/16/14 – Outfall Pipes

12/16/14 - View of the south wall of the washout.

10/24/14 – View of Outfall Pipes.

View of the Seekonk River from the washout

View of the south wall of the washout.

View of the washout area from inside the washout.

View of the washout, as seen from the top of the northern wall.

APPENDIX C – ESTIMATED AIR EMISSIONS

EXCAVATION EMISSIONS CALCULATIONS
Former Tidewater Facility
Pawtucket, Rhode Island

To estimate the emissions from excavation activities at the Former Tidewater Facility ("the Site"), GZA GeoEnvironmental, Inc. (GZA) used the following modified versions of the equations given in Appendix D of "Air Emissions from the Treatment of Soils Contaminated with Petroleum Fuels and Other Substances" (Eklund 1997):

First the total excavation emissions potential is calculated as a benchmark:

Total Excavation Emissions Potential:

$$E_{Potential} = C_{i,Soil} \times S_v \times \beta$$

Where,
$E_{Potential}$ = Total Mass of Component i in a given volume of soil in grams (g);
$C_{i,Soil}$ = Concentration of Component i in the Soil in micrograms of Component i per gram of Mixture (ug/g);
β = Typical Bulk Density in grams per cubic centimeter (g/cm^3) (assumed to be 1.5 g/cm^3); and
S_v = Volume of Soil Moved in cubic meters (m^3).

Average Total Emissions (detailed model):
If the Average Total Emissions calculated by this detailed model (Eklund 1997) exceeds the calculated Total Excavation Emissions Potential, the Total Excavation Emissions Potential will be used.

$$E = E_{PS} + E_{DIFF}$$

$$E_{PS} = \frac{P_i\ MW\ 10^6\ E_a\ S_v\ ExC}{R\ T}$$

$$E_{DIFF} = \frac{(C)(10{,}000)(SA)(t_v)}{\left(\frac{E_a}{K_{eq}k_g}\right) + \left(\frac{\pi t}{D_e K_{eq}}\right)^{1/2}}$$

Where,
E = Total Emissions from Excavation of Soil in g;
E_{PS}= Total Emissions due to Soil Pore Space Gas in g;
E_{DIFF} = Total Emissions due to Diffusion in g;
P_i = Partial Pressure of Component i in millimeters of mercury (mm Hg)[1];
MW = Molecular Weight in grams per mole (g/mol);
10^6 = Conversion Factor of cm^3/m^3;
E_a= Air-Filled Porosity (0.35 for wet, or compacted soil);
S_v = Volume of Soil Moved in m^3;
ExC = Soil-Gas to Atmosphere Exchange Constant (0.10 for wet soils);
R = Universal Gas Constant in mm-Hg*cm^3/mol/K (62,361 mm-Hg*cm^3/mol/K);

[1] Note that because the impacts at the Site are not pure-phase, we have used the partial pressure as opposed to the vapor pressure of the pure component.

T = Temperatures in K (assumed to be 15°C);
C = Mass Loading of Component i in soil in g/cm^3;
$10{,}000$ = Conversion Factor of square centimeters per square meter (cm^2/m^2);
SA = Emitting Surface Area in square meters (m^2);
D_e = Effective Diffusivity in Air in square centimeter per second (cm^2/s);
K_{eq} = Equilibrium Coefficient;
t_v = Time to excavate Volume of Soil Moved in seconds (s);
k_g = Gas-Phase Mass Transfer Coefficient in centimeter per second (cm/s) (Default of 0.15 cm/s); and
t = Time that the Instantaneous Emission Rate approximates the Average Emission Rate over the 360 second period that Emissions from Freshly Excavated Soil are assumed to be Significant in s (60 s as per Eklund).

P_i is calculated by:

For this scenario, the partial pressure was estimated using Raoult's Law assuming the constituents are in a mixture with the other organic matter in the soil.

Raoult's Law:

$$P_i = P_i^* x_i$$

Where,
P_i = Partial Pressure of the Component i in the Mixture;
P_i^* = Vapor Pressure of the pure Component i; and
x_i = Mole Fraction of the Component i in the Mixture (moles component/total moles).

$$x_i = \frac{10^{-6}\, C_{i,Mixture}\, MW_{Mixture}}{MW_i}$$

Where,
10^{-6} = Conversion Factor of kilogram per milligram (kg/mg);
$MW_{Mixture}$ = Molecular Weight of Mixture in g/mol (assumed to be 250 g/mol);
MW_i = Molecular Weight of Component i in g/mol; and
$C_{i,Mixture}$ = Concentration of Component i in the Mixture in milligrams of Component i per kilogram of Mixture (mg/kg).

$$C_{i,Mixture} = \frac{C_{i,Soil}}{TOC}$$

Where,
$C_{i,Mixture}$ = Concentration of Component i in the Mixture in milligrams of Component i per kilogram of Mixture (mg/kg);
$C_{i,Soil}$ = Concentration of Component i in the Soil in micrograms of Component i per gram of Mixture (ug/g); and
TOC = Fraction of Total Organic Carbon in the Soil (mg/kg).

We've assumed a soil temperature of 15^{o}C in our calculations. We have therefore utilized the Clausius-Clapeyron equation to calculate vapor pressures at 15^{o}C from those in the literature (typically 25^{o}C):

Clausius-Clapeyron Equation:

$$\ln\left(\frac{P_1}{P_2}\right) = \left(\frac{\Delta H_{vap}}{R}\right)\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

Where,
P_1 = Vapor Pressure at a Known Point;
P_2 = Vapor Pressure at a Given Point;
T_1 = Temperature at a Known Point in Kelvin (K);
T_2 = Temperature at a Given Point in K;
ΔH_{vap} = Enthalpy of Vaporization of Component i in kilojoules per mole (kJ/mol); and
R = Universal Gas Constant in kilojoules per Kelvin per mole (8.314E-03 kJ/K/mol).

C is calculated by:

$$C = 10^{-6}\, C_{i,Soil}\, \beta$$

Where,
10^{-6} = Conversion Factor of gram per microgram (g/ug);
$C_{i,Soil}$ = Concentration of Component i in the Soil in micrograms of Component i per gram of Mixture (ug/g); and
β = Typical Bulk Density in g/m^3; (assumed to be 1.5 g/m^3).

SA is calculated by:

$$SA = SA_{Open\ Ecavation\ 6-minute\ Segment} + SA_{Pile\ 6-minute\ Segment}$$
$$= 2 * SA_{Open\ Excavation\ 6-minute\ Segment} + 4 * d * \sqrt{SA_{Open\ Exacation\ 6-minute\ Segment}}$$

Where,
$SA_{Open\ Excavation\ 6-minute\ Segment}$ = Open Surface Area of 6-Minute Segment Excavation in m^2;
$SA_{Pile\ 6-minute\ Segment}$ = Open Surface Area of the 6-Minute Segment Pile in m^2;
d = Depth of 6-Minute Segment Excavation in m.

This calculation assumes the excavation and pile are shaped like prisms. According to Eklund (1997), “It is assumed that emissions from freshly excavated soil are significant for a period of 360 seconds, after which the soil is covered by subsequent layers of excavated material.” Therefore, dimensions of the pile and excavation were dividing into six minute segments. The areas of these 6-minute segments were estimated assuming a square 6-minute segment pile with the surface area of the top of the 6-minute segment pile being equal to the surface area of the bottom of the 6-minute segment excavation and the height of the 6-minute segment pile being equal to the depth of the 6-minute segment excavation.

K_{eq} is calculated by:;

$$K_{eq} = \frac{P_i\, MW\, E_a}{R\, T\, C}$$

Where,
P_i = Partial Pressure of the Component i in the Mixture in mm Hg;
MW = Molecular Weight in g/mol;
E_a= Air-Filled Porosity (0.35 for wet, or compacted soil);
R = Universal Gas Constant in mm-Hg*cm^3/mol/K (62,361 mm-Hg*cm^3/mol/K);
T = Temperatures in K (assumed to be 15°C);
C = Mass Loading of Component i in soil in g/m^3;

D_e is calculated by:

$$D_e = \frac{D_a\ (E_a)^{3.33}}{(E_T)^2}$$

Where,
D_a = Diffusivity in Air of Component i in cm^2/s (Default of 0.1 was used when chemical-specific values could not be found);
E_a= Air-Filled Porosity (0.35 for wet, or compacted soil); and
E_T= Total Porosity (Default of 0.625).

References:

Eklund, et al. 1997. Air Emissions from the Treatment of Soils Contaminated with Petroleum Fuels and Other Substances. Prepared for U.S. Environmental Protection Agency Office of Air and Radiation and Office of Research and Development Washington, D.C. EPA-600/R-97-116. October.

RIDEM. 2009. Air Pollution Control Regulation No. 9: Air Pollution Control Permits. December.

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Table C-1 Summary of Analytical Data used in Emissions Calculations

Drainage Improvements - South Washout Area
Former Tidewater Facility
Pawtucket, RI

	RIDEM GB Leachability Criteria	RIDEM Industrial/ Commercial DEC	RIDEM UCL	Date Units	RIDEM SS-5 July 1986	RIDEM SS-10 July 1986	W-BVE TP-10 (0-8 ft.) May 1988	W-BVE TP-11 (1-2 ft) May 1988	W-BVE TP-11 (2-13.5 ft) May 1988	W-BVE TP-12 (0.4-2.2 ft) May 1988	W-BVE TP-12 (4.2-10.5 ft) May 1988	W-BVE TP-13 (0.2-0.9 ft) May 1988	W-BVE TP-13 (6-14 ft) May 1988	W-BVE TP-14 (0.6-1.1 ft) May 1988	W-BVE TP-14 (1.8-7.8 ft) May 1988	SS-6 (0-2 ft) 1996	SS-19 (0-2 ft.) 1996	SS-43 (0-2 ft) 1996
EPA 8260B VOLATILE ORGANICS																		
Benzene	4,300	200,000	10,000,000	µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<1390	NA	<5
Ethylbenzene	62,000	10,000,000	10,000,000	µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,060	NA	<5
m&p-Xylene	NE	10,000,000	10,000,000	µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,790	NA	<5
Naphthalene	NE	10,000,000	10,000,000	µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<5
o-Xylene	NE	10,000,000	10,000,000	µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<130	NA	<5
Toluene	54,000	10,000,000	10,000,000	µg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<1960	NA	<5
EPA 8270C PAHS BY GCMS																		
Naphthalene	NE	10,000,000	10,000,000	µg/kg	ND	ND	48,000	ND	ND	ND	ND	ND	2800	**19000000**	ND	<8000	< 310	<5800

Notes:
NE = Not Established
NR = Not Reported
NA = Not Analyzed
ND = Not Detected (Detection Limit not Reported)
< XX = Not Detected below concentration XX
Table only indicates the compounds that were detected, other compounds
Table only shows explorations within 100 feet of the South Washout Area or Proposed Access Road with analytical samples collected in the top 10 feet of soil.
Averages presented in the table include half the detection limit (if reported)
Gray shaded cells and **bolded text** indicates the concentration exceeds the
Concentrations **bolded and underlined** exceed the RIDEM Method 1 GB Leachability Criteria.
A concentration with a bold border exceeds the Upper Concentration Limit.

Table C-1 Summary of Analytical Data used in Emissions Calculations

Drainage Improvements - South Washout Area
Former Tidewater Facility
Pawtucket, RI

	RIDEM GB Leachability Criteria	RIDEM Industrial/ Commercial DEC	RIDEM UCL	Date Units	SS-44 (0-2 ft.) 1996	TB-4 (0-2 ft) 1996	TB-5 (0-2 ft.) 1996	TP-2 (1-2 ft.) 1996	TB-6 (0-2 ft) 1996	TB-5 (4-6 ft.) 1996	TP-1 (8-9 ft) 1996	TP-110 (0-2 ft) 2006	TP-110 (5.5-6.5 ft) 2006	MW-319D S-5 (8-10ft.) 05/14/2010	MW-321D 0-4ft 05/10/2010	MW-321D 4-8ft 05/10/2010	Average (µg/kg)	Maximum (µg/kg)
EPA 8260B VOLATILE ORGANICS																		
Benzene	4,300	200,000	10,000,000	µg/kg	< 31,000	<5.6	NA	**116,000**	NA	1,790	<210	126	<253	< 9,600	<200	<280	11,616	116,000
Ethylbenzene	62,000	10,000,000	10,000,000	µg/kg	< 31,000	<5.6	NA	**71,900**	NA	1,990	450	<61.1	<253	< 9,600	<200	<280	8,009	71,900
m&p-Xylene	NE	10,000,000	10,000,000	µg/kg	52,000	<5.6	NA	182,000	NA	8,290	160	198	<759	< 9,600	<390	<550	20,864	182,000
Naphthalene	NE	10,000,000	10,000,000	µg/kg	NA	<5.6	NA	NA	NA	NA	NA	860	<253	1,200,000	<390	<550	171,677	1,200,000
o-Xylene	NE	10,000,000	10,000,000	µg/kg	< 31,000	<5.6	NA	95,400	NA	4,690	<210	NA	NA	< 9,600	<200	<280	12,095	95,400
Toluene	54,000	10,000,000	10,000,000	µg/kg	**59,000**	<5.6	NA	**254,000**	NA	5,370	200	213	<253	< 9,600	<200	<280	27,090	254,000
EPA 8270C PAHS BY GCMS																		
Naphthalene	NE	10,000,000	10,000,000	µg/kg	**14,000,000**	4,850	1,660	6,950,000	120,000	267,000	1,060	3,490	<7520	2,000,000	<330	2,400	1,631,238	19,000,000

Notes:
NE = Not Established
NR = Not Reported
NA = Not Analyzed
ND = Not Detected (Detection Limit not Reported)
< XX = Not Detected below concentration XX
Table only indicates the compounds that were detected, other compounds
Table only shows explorations within 100 feet of the South Washout Area or Proposed Access Road with analytical samples collected in the top 10 feet of soil.
Averages presented in the table include half the detection limit (if reported)
Gray shaded cells and **bolded text** indicates the concentration exceeds the
Concentrations **bolded and underlined** exceed the RIDEM Method 1 GB Leachability Criteria.
A concentration with a bold border exceeds the Upper Concentration Limit.

Table C-2 Excavation Emissions Potential

Drainage Improvements - South Washout Area
Former Tidewater Facility
Pawtucket, RI

Site-Specific		
Volume of Soil - Excavation	890	(cy)
Volume of Soil Moved	890	(cy)
Volume of Soil Moved	669	(m^3)
Factor of Safety	2	

Constants			
Typical Bulk Density	1.5	(g/cm^3)	Eklund 1997 Default

Conversion Factors	
ft/m	3.3
ft^3/cy	27
g/lb	454
g/kg	1000

Analyte	Average Measured Concentration in Soil (µg/g)	Maximum Measured Concentration in Soil (µg/g)	Total Excavation Emissions Potential[1] (lb)	Total Excavation Emissions Potential[2] (lb)	RIDEM Annual Minimum Quantity (lb)
Benzene	12	116	2.57E+01	2.56E+02	1.00E+01
Toluene	27	254	5.99E+01	5.61E+02	1.00E+03
Ethylbenzene	8	72	1.77E+01	1.59E+02	9.00E+03
Xylene P,M	21	182	4.61E+01	4.02E+02	3.00E+03
Xylene O	12	95	2.67E+01	2.11E+02	3.00E+03
Naphthalene	1,631	19,000	3.61E+03	4.20E+04	3.00E+00

Notes:
1. Total Excavation Emissions Potential based on Average Measured Concentration in Soil.
2. Total Excavation Emissions Potential based on Maximum Measured Concentration in Soil.
3. Only detected analytes with Rhode Island Department of Environmental Management (RIDEM) minimum quanitity values are shown.
4. Naphthalene concentrations presented in this model are the maximum of napthalene analyzed as a VOC or as a PAH
5. cm = centimeter; m = meter; g = gram; µg = microgram; ft = feet, lb = pound; kg = kilogram; cy = cubic yard.
6. Yellow Highlighting indicates model inputs.
7. Blue Highlighting indicates the calculated Total Excavation Emissions Potential exceeds the RIDEM Minimum Quantity.

Table C-3 Predicted Excavation Emissions

Drainage Improvements - South Washout Area
Former Tidewater Facility
Pawtucket, RI

Assumptions		
Assumed Average MW of NAPL	250	(g/mol)
Assumed NAPL Temperature	15	(°C)

Site - Specific -Total		
Emitting Surface Area (SA)	7.39	(m^2)
Volume of Soil Moved	890	(cy)
Volume of Soil Moved (SV)	669	(m^3)

Site-Specific - Clearing and Grubbing		
Excavation Surface Area	1,700	(ft^2)
Excavation Average Depth	1.0	(ft)
Excavation Surface Area	171	(m^2)
Pile Surface Area	171	(m^2)
Emitting Surface Area (SA)	4.35	(m^2)
Volume of Soil Moved	130	(cy)
Volume of Soil Moved (SV)	98	(m^3)
Time to Excavate Soil	8	hrs
Factor of Safety	2	

Site-Specific - Setting Manholes		
Excavation Diameter	5	(feet)
Excavation Average Depth	6	(ft)
Excavation Surface Area	23	(m^2)
Pile Surface Area	23	(m^2)
Emitting Surface Area (SA)	0.22	(m^2)
Volume of Soil Moved	20	(cy)
Volume of Soil Moved (SV)	15	(m^3)
Time to Excavate Soil	24	hrs
Factor of Safety	2	
Number of Manholes	2	

Site-Specific - Access Road		
Length of Access Road	400	(LF)
Width of Access Road	25.0	(ft)
Depth of Excavation for Access Road	1	(ft)
Excavation Surface Area	957	(m^2)
Pile Surface Area	957	(m^2)
Emitting Surface Area (SA)	2.82	(m^2)
Volume of Soil Moved	740	(cy)
Volume of Soil Moved (SV)	556	(m^3)
Time to Excavate Soil	72	hrs
Factor of Safety	2	

Constants			
Typical Bulk Density	1.5	(g/cm^3)	Eklund 1997 Default
R	8.21E-05	(m^3*atm/K/mol)	
R	8.31E-03	kJ/(K*mol)	
R	62,361	mm Hg*cm^3/mol*K)	
Soil Gas to Atmosphere Exchange Constant (Dry, uncompacted Soils)	0.33	(%/100)	Eklund 1997 Default
Air-Filled Porosity (Dry, uncompacted Soils)	0.55		Eklund 1997 Default
Total Porosity (Uncompacted Soils)	0.55		Eklund 1997 Default
Gas-Phase Mass Transfer Coefficient	0.15	cm/s	Eklund 1997 Default
Time since Start of Excavation of Soil of Interest	60	s	Eklund 1997 Default
Time Period Excavated Soil are Emitting Contaminants	0.1	(hr)	Eklund 1997 Default
TOC of Soil	0.006	(g OC/g soil)	

Analyte	Average Measured Concentration in Soil (µg/g)	Partial Pressure[1] (atm)	Equilibrium Coefficient	Effective Diffusivity in Air (cm^2/s)	Total Excavation Emissions Potential[2] (lb)	Total Excavation Emissions (lb)	RIDEM Annual Minimum Quantity (lb)
Benzene	12	1.19E-03	1.24E-01	4.21E-02	2.57E+01	2.11	10
Naphthalene	1,631	2.95E-05	3.59E-05	2.66E-02	3.61E+03	0.09	3

Notes:
1. The Partial Pressure was calculated using Raoult's Law.
2. If the calculated Total Excavation Emissions exceeds the Total Excavation Emissions Potential, the Total Excavation Emissions Potential was used as the Total Excavation Emissions.
3. Naphthalene concentrations presented in this model are the maximum of napthalene analyzed as a VOC or as a PAH
4. Only detected analytes with RIDEM minimum quanitity values are shown with Total Excavation Emissions Potentials above RIDEM minimum quantities.
5. Concentration units are in µg/g, which is equal to ppm.
6. MW = molecular weight; atm = atmosphere; kJ = kilojoules; mol = moles; NAPL = non-aqueous phase liquid; ppm = parts per million; mm Hg = millimeter mercury; cm = centimeter; m = meter; g = gram; µg = microgram; ft = feet, lb = pound; s = second; yr = year; hr = hour; < = less than the reporting limit; TOC = total organic carbon.
7. Yellow Highlighting indicates model inputs.
8. Red Highlighting indicates the Total Excavation Emissions exceeds the Rhode Island Department of Environmental Management (RIDEM) Minimum Quantity.

APPENDIX D – APRIL 2011 AQMP
AND MAY 2011 FOLLOW UP CORRESPONDENCE

NATIONAL GRID
AIR QUALITY MONITORING PLAN
PLANNED SHORT DURATION PROJECTS – FORMER TIDEWATER MGP

INTRODUCTION

GZA GeoEnvironmental, Inc. (GZA), on behalf of The Narragansett Electric Company d/b/a National Grid (National Grid), has prepared this Air Quality Monitoring Plan (AQMP) for use on certain planned projects at the Tidewater Site located in Pawtucket, Rhode Island. Projects covered by this plan include: (1) the *Short Term Response Action Plan* associated with removal of a former process pipe (STRAP submitted to RIDEM in October 2010 and subsequently revised in January 2011); (2) the planned gas regulator station upgrade work; and short duration site investigation activities (test pits, borings). This AQMP is designed to provide for a consistent approach to air quality monitoring for these relatively short-duration remediation, construction, and/or maintenance activities.

While air monitoring requirements for more intrusive and longer duration projects may follow the same general procedures described herein, this AQMP is not intended to cover these more significant and intrusive efforts. Specific air monitoring requirements for these types of efforts will be evaluated on a case by case basis by National Grid as part of the planning, design, permitting and RIDEM-approval process. It is our intent to modify this air monitoring approach for future efforts at the Tidewater Site based on data collected during the activities listed above.

This AQMP for the Tidewater site was designed to achieve the following primary objectives:

- Estimate potential vapor emissions for these short duration efforts in accordance with United States Environmental Protection Agency (EPA) methodology and assess the applicability of RIDEM Air Pollution Control (APC) Regulation No. 9 on a case by case basis;

- Minimize exposure risks to both on-site workers and the surrounding community associated with airborne constituents during implementation of short term remediation, investigation, construction, and/or maintenance activities at the Tidewater site;

- Provide an early warning of site conditions allowing oversight personnel to proactively manage potential air quality issues via implementation of engineered controls and/or adjustments to work practices/procedures[1]; and

[1] Please note, anticipated engineered controls and work practices are not described in this AQMP. These procedures are specific to each activity and will be described in the plans, workplans, STRAPs, etc. developed for each effort.

- Quantify air quality monitoring data and compare to applicable criteria to ensure compliance with this AQMP.

VAPOR EMISSION MODELING

Initial project planning activities for each of the short duration events currently anticipated at the Tidewater site will include an estimate of potential volatile air emissions for the proposed work using EPA methodology. Specifically, potential emissions from the proposed activities will be estimated and quantified using the general modeling approach and guidelines presented in the following published EPA guidance document:

- Eklund, et al. 1997. <u>Air Emissions from the Treatment of Soils Contaminated with Petroleum Fuels and Other Substances</u>. Prepared for U.S. Environmental Protection Agency Office of Air and Radiation and Office of Research and Development Washington, D.C. EPA-600/R-97-116. October.

An appropriate predictive air emission model will be developed based on these EPA guidelines for each effort. The results of the predictive modeling will be used to evaluate whether the activity has the potential to increase emissions by greater than the minimum quantity as specified in Appendix A of RIDEM APC Regulation No. 9 and whether a minor source permit is required. A summary of the predictive modeling and our evaluation of the results will be submitted to RIDEM prior to proceeding with on-site work.

AIR QUALITY MONITORING STRATEGY

The following monitoring program will be implemented for each of the short duration efforts anticipated at the Tidewater site regardless of the outcome of the above described predictive air modeling results[2]. This air quality monitoring program has been designed to be protective by using a two tiered approach; real-time air monitoring, and time integrated sampling using US EPA approved sampling and analytical methods. The real time monitoring will involve the use of hand held instrumentation deployed upwind and directly downwind of the site work zone and at the nearest downwind location along the site property line. The first tier (real time monitoring) is designed to provide an early warning to site personnel of potential air quality issues and allow for the implementation of engineered controls and/or modifications to work practices. The second tier, time integrated, laboratory sampling, involves the deployment of stationary sampling equipment at the nearest property line directly downwind of the site work zone(s) and at an upwind perimeter location. This second tier is designed to assess and document perimeter air quality during these activities.

The means and methods associated with each tier of sampling are described in the last section of this plan.

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[2] We understand that in instances where a Minor Source Permit is applicable, additional air monitoring requirements may be necessary.

SELECTION OF TARGET COMPOUNDS

The selection of target compounds for this monitoring plan is based on guidance presented in a document entitled "Health-based Guidelines for Air Management, Public Participation, and Risk Communication During the Excavation of Former Manufactured Gas Plants" prepared by Wisconsin Bureau of Environmental and Occupational Health, Department of Health and Family Services (DHFS) dated August 24, 2004. A copy of the Wisconsin Guideline document is included as Attachment A.

The target compounds selected for the real-time component of this air monitoring program include: Total Volatile Organic Compounds (TVOC) and respirable particulate matter (PM10). In addition, supplemental real-time monitoring will be conducted for benzene. Real time supplemental monitoring for naphthalene was also considered. However, since the instrument which is used to monitor naphthalene in real-time (zNose Model 4200/4300) is typically used as a screening tool and not a quantitative instrument for comparison to air quality standards, it is not considered appropriate for this application. Further, the zNose has a lower detection limit that is approximately ten times higher than the 24-hr RI Acceptable Ambient Level (AAL) for naphthalene, thus would be of limited value in quantifying ambient air quality. The time-integrated sampling and analyses described herein provides a more representative measure of air quality in comparison to the RIDEM AALs. As described further below, target compounds for the time integrated sampling component of this project will include benzene, toluene, ethylbenzene, xylenes, and naphthalene, which are a subset of the analytes contained within the USEPA Method TO-15 (VOCs).

ACTION LEVELS

This section presents the action levels for both tiers of sampling (real time and time integrated).

The following real-time monitoring action levels for the work zone perimeter and property line were selected for use on these shorter duration efforts. These action levels were adopted from Table 3 of the attached Wisconsin Guidance document. The determination of a work zone action level exceedance will be based on the difference between the upwind (background) sampling results and the downwind sampling results. The property line real time monitoring will be conducted at the nearest location downwind from the activity. In addition, real time monitoring will also be conducted at the property line adjacent to the nearest sensitive receptors west of the site, including the apartment complex, the International Charter School and the Francis J. Varieur School independent of wind direction.

Table 1 Action Levels – Real Time Monitoring

Compound	Work Zone Perimeter	Property Line
Total Volatile Organic Compounds (TVOC)	1.0 ppm	0.5 ppm
Respirable Particulate (PM10)	1,000 ug/m3	150 ug/m3
Benzene	NA	0.35 ppm

In the event these real time action levels are exceeded GZA will immediately identify the likely cause, implement appropriate engineering controls, and/or modify work practices. In addition, on any day when the real time monitoring exceed these action levels, time integrated samples from upwind and downwind property line locations will be sent to the laboratory for analysis (see below).

The following action levels were selected for use during the time integrated sample monitoring for benzene, toluene, ethylbenzene and xylenes (BTEX), and naphthalene. This compound list was developed based on the DHFS document and our experience at other MGP sites. The approach for selecting representative "sentinel" compounds, as presented in the DHFS document, is based on the fact that there are many different VOCs potentially present in MGP wastes and that the selected compounds should "be based on both the risk imparted by a compound's prevalence and toxicity, as well as the analytical ability to detect these compounds". The action levels were obtained from Table 4 of the Wisconsin Guidance document and are based on the DHFS recommended maximum 24-hour average concentration.

Table 2 Action Levels – Time Integrated Samples (Property Line)

Compound	Wisconsin Action Level (24 hour average)	RIDEM AAL (24 hour)	Proposed Action Levels (24 hour average)[3]
Benzene	10 ppb	6.2 ppb	6.2 ppb
Toluene	94 ppb	80 ppb[4]	80 ppb
Ethylbenzene	230 ppb	692 ppb	230 ppb
Xylenes	23 ppb	692 ppb	23 ppb
Naphthalene	20 ppb	0.6 ppb[5]	20 ppb

In the event time integrated perimeter sampling results indicate levels in excess of these action levels, the on-going activities will be shutdown and engineered controls and work practices will be re-evaluated in consultation with RIDEM prior to re-initiating on-site work. As indicated below, these time integrated sampling results will be available 24-48 hours after collection.

[3] Action levels represent the lower of the DHFS and RIDEM AAL with the exception of naphthalene. DHFS action level for naphthalene is based on a subchronic exposure which is more appropriate for these shorter duration efforts than the AAL for naphthalene which is based on chronic exposure assumptions.
[4] RIDEM does not have a 24-hour AAL for toluene. This value based on RIDEM annual AAL for toluene.
[5] The listed 24 hour AAL for naphthalene is based on chronic exposure assumptions.

MEANS AND METHODS FOR REAL-TIME AND TIME INTEGRATED MONITORING

Real-Time Monitoring

The real time air monitoring is designed to measure site-related airborne constituents, namely volatile organic compounds (VOCs) and respirable particulate (PM10). Real-time methods for monitoring particle bound PAHs do not exist, thus particle levels will be used as a surrogate for PAHs. The equipment associated with the real time air monitoring are field photoionization detectors (PIDs) for TVOCs and continuous respirable particle monitors.

Volatile Organic Compound (VOC) Air Monitoring

During the activities described herein, the real-time air monitoring equipment will be maintained at the site to monitor VOC concentrations associated with the site remedial/maintenance activities. During these activities, a PID will provide continuous air quality measurements from sampling locations upwind and directly downwind of the work zone and the Site perimeter. Perimeter locations will be selected based on wind direction and the location of the nearest potential sensitive receptors. The real time air quality measurements will be compared to the action levels presented in Table 1 (after subtracting background concentrations) in order to assess the need for implementation of engineering controls and/or modifications to work practices. If the total VOC action level is exceeded, the contractor will be informed, potential sources of the exceedance will be investigated and, if appropriate, mitigation activities will be initiated. In addition, an exceedance of the TVOC Action Level downwind of the work zone will trigger the analysis of a time integrated sample from the site perimeter (see Time Integrated Monitoring discussion below).

Volatile organic substance concentrations will be measured utilizing a portable photoionization detector (Photovac 2020 PID) or equivalent. The PIDs measure volatile organic compounds by passing the air sample past an analytical detector and electronically measuring the resulting response. The PIDs are configured to respond to total organic compounds without any differentiation as to individual compound concentrations. The limit of detection is 10 parts per billion by volume (ppbv). The PID will be operated in accordance with manufacturers specifications.

Respirable Particulate Matter (RPM10) Perimeter Air Monitoring

As described above, real-time monitors for PAHs do not exist. Therefore, respirable dust will be measured as an indirect measure of ambient PAH levels.

Direct-reading real-time particulate meters (DustTrak) will be used to monitor for particulate (or dust). The measurement of dust levels is accomplished using infrared electromagnetic radiation to sense airborne particles. The dust meter will be configured to respond only to dust particles < 10 micron in diameter (PM10). The limit of detection is 1 ug/m^3 (microgram per cubic meter). The DustTrak will be operated in accordance with manufacturers specifications.

Gas Chromatographs (benzene) Supplemental Monitoring

Real time benzene concentrations will be measured utilizing a portable field gas chromatograph (Photovac Voyager GC). The GC measures volatile organic compounds by passing an air sample through a series of analytical columns to separate individual compounds and then by an analytical detector, which electronically measures the resulting response and compares it to a known concentration response of each compound of interest. The GC will be calibrated to a known concentration of benzene each day prior to monitoring activities. The detection limit for benzene is 10 parts per billion (ppb). The GC will be operated in accordance with manufacturers specifications.

Time Integrated Monitoring

Time integrated air quality samples will be collected at the perimeter, at an upwind and a downwind location in order to document ambient levels of target VOCs presented in Table 2 of this plan using US EPA approved sampling and analytical methods. Samples will be collected daily during intrusive activities. Samples will be submitted for analysis if the results of the first tier, real time air quality monitoring (at either the work zone or the perimeter location) indicates an exceedance of the established action level presented in Table 1. In addition, regardless of the results of the real-time monitoring, at least one set of time integrated samples will be collected during each activity. Analyses will be performed by an accredited off-site analytical laboratory demonstrating proficiency for the specific methods stated in this section. The laboratory results will be available 24 to 48 hours after collection.

Volatile Organic Compounds

At a minimum, two VOC samples, one upwind and one downwind, will be collected during each day when intrusive activities are being performed. One additional sample will be used as a field blank and will be submitted along with the field samples to the laboratory. The sampling locations will be chosen based on actual and predicted wind conditions for the sampling day. VOC samples will be collected using SUMMA stainless steel canisters in conjunction with US EPA Method TO-15 GC/MS Full Scan, as presented in "The Compendium of Methods for the Determination of Toxic Organic Compounds in the Ambient Air". The VOC samples will be analyzed for the compounds presented in Table 2 by an off-site certified laboratory. The SUMMA canister method consists of the collection of a whole air sample into an evacuated stainless steel canister. The canister is passively filled with sample air via a mass flow controller which allows for uniform filling of the canister over the eight hour sampling period.

Documentation and Reporting

The real time field data and any time integrated sampling results will be maintained by GZA on-site. In addition, this air monitoring data will be presented in completion reports submitted to RIDEM for each effort.

Attachment: Health-based Guidelines for Air Management, Public Participation, and Risk Communication During the Excavation of Former Manufactured Gas Plants" prepared by Wisconsin Bureau of Environmental and Occupational Health, Department of Health and Family Services (DHFS) dated August 24, 2004

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Wisconsin DHFS: Manufactured Gas Plant Air Guidance

Health-based Guidelines for Air Management, Public Participation, and Risk Communication During the Excavation of Former Manufactured Gas Plants

Robert Thiboldeaux and Henry Nehls-Lowe, Wisconsin Bureau of Environmental and Occupational Health, Department of Health and Family Services

Introduction

Purpose and intended audience. The purpose of this guidance is to provide public health expectations and recommendations for managing air quality at the perimeter of manufactured gas plant (MGP) cleanup sites in order to minimize exposure to the public.

This guidance is intended for project managers, representing both environmental regulatory agencies and private consultants, who are working with MGP remediations. Environmental consultants and contractors having a range of experience with MGP work have undertaken MGP projects in Wisconsin. This experience ranges from MGP remediation specialists using state-of-the-art techniques to more generalized environmental consultants and contractors working on small MGP sites, perhaps as one component of a much larger construction project. Similarly, DNR project managers have a range of experiences. Most work on a variety of remediation projects, but because there are relatively few MGP sites in the state, may be involved in a MGP project for the first time.

This guidance is also intended to complement information on MGP remediation already available to the Energy and Environmental industries. *Management of Manufactured Gas Plant Sites* (GRI 1996), in limited circulation from the Gas Research Institute, is an extensive introduction to MGP technical issues. Much of the information in this guidance is at least topically referenced in the GRI text. This guidance expands on emerging technical and regulatory issues related to air quality and air management around MGP sites, with emphasis on public health.

Manufactured gas plants in Wisconsin. Manufactured gas plants operated in Wisconsin from the late 1800s to the mid-twentieth century. These facilities produced fuel gas comprised of methane, hydrogen, carbon monoxide, nitrogen, and other gases produced (Buckley 1983, GRI 1996) by heating coal, steam and coke, or steam and oil. In Wisconsin, some of these former manufactured gas plant (MGP) sites retain original buildings; others have since been converted to other uses but still have subsurface MGP wastes. Coal tars, light oils, and inorganic wastes typically found in soil, sediment, and groundwater near former MGPs are an environmental and public health concern.

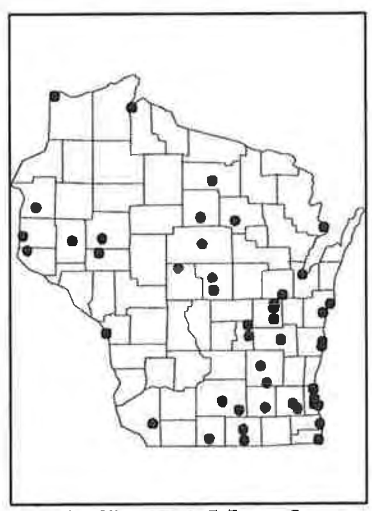


Figure 1. Former Manufactured Gas Plants are found throughout Wisconsin

DHFS role in evaluating former MGP sites. The Wisconsin Department of Health and Family Services (DHFS) supports the long-term public health and environmental benefits of MGP remediations, but recognizes the potential for short-term environmental health problems caused by the clean-up work. To prevent health problems, DHFS provides technical advice to the lead regulatory agency, usually the Wisconsin Department of Natural Resources (DNR), on public health issues related to MGP projects. DHFS also participates in statewide policy discussions conducted by the DNR manufactured gas plant team. The DNR has identified more than forty five sites in Wisconsin (Figure 1) for investigation and possible remediation. The type and extent of contamination, as well as the remediation challenges, vary with the size of the original operation, the gas manufacturing process used, and the physical geography of the remediation site. Most of these sites are in locations that are now urban areas or town centers. The proximity of residences and business to these sites presents the additional challenge of avoiding exposure hazards to the public during cleanup work.

Identification of air impacts as a key public health concern during MGP remedies. In Wisconsin, people have been exposed to MGP-related hydrocarbons through contact exposure to tar-contaminated surface water and sediment, through contact with subsurface tars by workers digging trenches, and by inhalation of volatile organic hydrocarbons (VOCs) released during excavation. In addition, the ingestion of well water contaminated with MGP wastes is a potential threat that is being monitored at some MGP sites in Wisconsin. Of the identified exposure pathways, the release of hydrocarbons to air during remediation work has the greatest potential to affect the general public. MGP-related contaminants may become airborne during removal, either through volatilization, or dispersed as soil dust. People who live or work nearby can be affected by air containing these substances. Nationwide, there has been increased emphasis on emissions control and air monitoring during MGP cleanups (Pluhar 2004). The recommendations proposed here seek to minimize the public's exposure to airborne contaminants from MGP sites.

Odor vs. safety: nuisance vs. measurable health effects. An important topic of this paper is its address of odor control at MGP sites as a public health issue. Air monitoring data from MGP sites in Wisconsin indicates that site managers have been generally successful at maintaining federal standards and guidelines for safe ambient air quality. Unfortunately, even at safe levels for VOCs and particulates, strong tar odors may still be evident. The gap between safe and "odor free" can affect public acceptance of an MGP project, especially when there are neighbors with either a real or perceived increased health risk from airborne exposure to MGP wastes. When MGP sites are excavated in sensitive public locations, it is advisable to extend air management of volatile compounds beyond existing health and environmental guidelines, and set air management targets that are closer to odor thresholds. DHFS recognizes that this is technically challenging and not always feasible. However, leading environmental consultants and utility companies conducting MGP projects in Wisconsin have been responsive to the goal and the challenges of controlling tar odors. This guidance does not advocate for specific air management targets beyond existing standards and guidelines. But, as a practical public health and community relations' goal, DHFS believes that neighbors of MGP excavation and treatment projects should be able to escape tar odors within the refuge of their homes when doors and windows are closed. Meeting this practical goal will sometimes entail adopting stringent site management methods and increased emphasis on community outreach.

Developing an Air Management Plan

The Air Management Plan (AMP) lays out the key factors related to the project and surrounding area that influence the potential for air quality problems. The Air Management Plan can be considered in four parts. 1) Identify, and communicate with, the nearby population that could be affected by air quality from the site. 2) Establish measurable and protective air quality goals and action levels based on contaminant concentrations and distance from community members. 3) Identify the appropriate monitoring methods for the contaminants of concern. 4) Plan the overall project to minimize air quality impacts, and develop an action plan of responses to be taken when action levels are exceeded. Air management issues of this nature are inherently complex, making it important to have a contingency plan with feedback and response loops that detect and accommodate changing or unforeseen conditions.

Conceptual Air Management Plan. Responsible parties and their consultants are encouraged to contact state environmental and health agencies early in the project planning process to discuss a conceptual plan of the project. Contacting interested agencies at the conceptual stage allows ideas to be presented and concerns to be raised before investing effort in plans that might require extensive revision. This is especially true for unusual projects or for parties new to the State of Wisconsin. The development of cooperative, helpful relationships with agency staff is an added benefit in any remediation project.

Community Involvement

Informing neighborhoods and building public acceptance for MGP remedies. Most environmental consultants have a good deal of experience planning the logistics of a cleanup. Characterizing community interests that relate to air management can be a more complicated process. It is important to identify as much as possible where the nearest residents or workers will be with respect to the cleanup. Pay close attention to the locations of sensitive populations such as schools, hospitals, daycare centers, or nursing homes. The air management plan is designed to protect each of these populations from unhealthy exposures to contaminants from the cleanup project. The characteristics of the nearby population will play a role in decision-making when scheduling the project dates, operating times of day, planning truck routes, on- or off-site treatment, as well as the locations and types of perimeter air monitoring that would be conducted.

Public outreach is important *prior to* and *during* any MGP site remediation, both to avoid problems and alleviate concerns. Public meetings and literature should permit the public to anticipate odors and other air emissions, and their effects. Fact sheets and public meetings can be used to inform the public of site activities. Special efforts should also be made to identify and inform sensitive or less mobile people in the affected area.

Regulatory requirements for community involvement. In Wisconsin, parties responsible for contaminated sites, including former MGPs, have requirements under Chapter NR 714.07(1-6) of the Wisconsin Administrative Code for public information and participation (see http://www.legis.state.wi.us/rsb/code/nr/nr700.html). Each responsible party must evaluate the need for informing the community about the contaminants and the cleanup plan, and then decide on the best methods for sharing the information with the public. This may include posting signs, holding meetings, developing fact sheets, sending letters, etc. Further, if the DNR determines that these activities are not adequate, the department may require the responsible party to conduct specific public information activities. In addition, state and local officials such as DNR, DHFS, the local Health Department, and local government may choose to conduct public information activities. These activities might be conducted independently from, or in cooperation with, the activities required of responsible parties. Cooperative efforts between responsible parties and environmental, health, and government officials can be challenging, but ultimately builds credibility and accelerates community acceptance of the MGP remediation project.

Benefits of risk communication. Despite the long-term public health benefits of the remediation of former MGPs, there is often public concern over possible health effects from air releases during the clean-up work. Such concerns speak directly to public acceptance of MGP remediations, and sometimes results in organized resistance to particular projects. Risk communication efforts should anticipate community concerns, should seek to provide credible and authoritative information, and recognize the community as a stakeholder in local environmental quality with a right to community self-determination. State and local health departments are staffed with people trained in environmental risk communication who are available to assist, where appropriate, with public information activities. The responsible party may also choose to develop a local representative to serve as a credible point-of-contact and liaison to the public. For resources on risk communication, see bibliography.

Points of contact from public. A 24-hour phone number should be available to public and businesses so they can call with questions or complaints. To be most responsive to the community, the phone "hotline" should request specific information from callers, such as weather conditions, an odor description, and any health symptoms. The hotline should also tell the caller what would be done with the information they provide. Site managers need to immediately follow-up on air incidents and odor complaints in order to ensure that complaints have been appropriately treated and to avoid repeat events.

The point-of-contact representing remediation management should maintain, in the form of a phone log, a record of the public's phone inquiries and complaints. The phone log should note the contractor's response to each inquiry, and should be available to regulatory inspection, to be submitted at the project's completion along with the other permanent records of the work.

Identifying, accommodating, and communicating with individuals with special needs. One of the public health challenges associated with MGP remediation projects is to identify and accommodate neighbors who are extremely sensitive to the VOCs released from soil and groundwater. In Wisconsin, MGP site managers are usually quite successful in limiting air releases to within the safe levels agreed upon in air management plans. However, maintaining these safe levels may not preclude the presence of coal tar odors. These odors can be irritating, and people vary in their tolerance of odor and their perceived risk from exposure (Dalton *et al.* 1997, Dalton 1996). Other people may have conditions such as bronchitis, emphysema, or asthma (see DHFS 2001 for prevalence) that present additional unknowns from low level exposure. To address these unknowns, DHFS recommends first, that every effort be made to mitigate coal tar odors beyond established standards and guidelines such that nearby residents can not smell odors indoors when doors and windows are closed. Second, prior to the excavation, every individual within a close radius (approximately 200-400 yards, depending upon the site) of the excavation should be personally informed of the work by letter or phone call. This contact should inform neighbors that air quality will be maintained at safe levels, but if they have any preexisting health condition that is a concern, then they may contact the health department and/or their physician for advice. The information provided must be clear and sufficient to allow individuals to self-identify their need to seek additional advice. The points-of-contact representing both the responsible party and local health should be mutually aware of any individuals responding with advance concerns. Third, responsible parties should have advance agreement with local health officials over how they will accommodate individuals reporting actual health complaints ranging from a nuisance odor to acute respiratory effects. Such accommodation might range from simple advice and reassurance (close windows, dispatch technician with PID to home) to providing temporary relocation where necessary.

Accommodating individuals, particularly involving relocation, is a public risk perception challenge. People may become concerned unnecessarily because they want to be treated equally and may not recognize individual needs. Also, it is difficult to evaluate individual needs that may only manifest as a temporary discomfort or irritation to the evaluator, but may be intolerable to the complainant. For these reasons, health concerns and complaints raised after excavation commences should also be directed to a physician. Health departments and other stakeholders should be prepared to provide descriptions of the MGP project to physicians that will help them evaluate exposure. Stakeholders should have advance agreement of the accommodations that will be made following a physician's recommendation. Such agreements may require extended discussions among stakeholders of possible complaint scenarios, but at sensitive locations where complaints are expected, advance discussions and agreements will ultimately help the remediation to proceed smoothly.

Reporting. DHFS, DNR, and the Local Health Department should receive weekly reports by email or fax during MGP remediation work. These reports should include the status of site activities, perimeter air monitoring data & reports, daily exposure air monitoring reports, calls or contacts about odor or health questions or complaints from the public and nearby businesses, and a copy of air monitoring logs from the portable air sampling program.

DNR, DHFS and the Local Health Department should be directly notified by phone or email if there are health or odor complaints, or if site activities result in air conditions that exceed agreed-upon "alarm" conditions. Also, someone with access to the air-monitoring log should be available at all times to address odor complaints from the public. The air management plan should include details for a 24-hour emergency telephone line to take calls from the public or from regulatory agencies. Records of these calls should be maintained to include who, what, why, and the response to each call. Part of the planned response to odor complaints should be to dispatch a portable instrument to the site of the complaint in order to verify there is a problem or to provide reassurance that odors are within safe levels. The log should include all readings collected during the perimeter monitoring, samples collected (when and where), and actions taken in response to any high values.

Other important avenues of communication. Environmental contractors should continually strive to improve site management. In particular, communication between contractors and subcontractors, via the site Health and Safety Officer, should ensure that defined protocols are followed.

DHFS recommends following completion of the site remedy, that DNR project managers debrief their regional member of the MGP team to discuss lessons learned with regard to air management.

Airborne Contaminants of Concern at MGP Remediation Sites

Major components, of MGP wastes found in soil and groundwater. MGP sites are typically contaminated with a complex mixture of coal tars and inorganic wastes (Table 1; Figure 2). These residual process or coal tars are primarily represented by 500 to 3000 separate polycyclic aromatic hydrocarbons (PAHs) of three to six benzene rings, phenolics, volatile organic compounds (VOCs), and inorganic compounds of sulfur and nitrogen (Hatheway 2002). MGP production wastes also included large quantities of ammoniacal liquors (spent condensation waters of coal gas plants), and gas liquors (spent condensation waters of carburetted water gas plants). Also common were tar sludges removed from the sumps of the condensation devices. MGP oxide box wastes contain high concentrations of sulfur oxides and metal cyanides (Luthy *et al.* 1994). Groundwater contamination by light oils and tars is also common, depending upon the location and method of disposal of MGP wastes, and the depth and confinement of perched water and groundwater aquifers at individual sites. Many former MGPs were sited along waterways that now have public access. At a number of such sites in Wisconsin, DHFS has observed MGP exposed oxide box wastes in soils, and coal tar and oil sheens around soil, sediments, and surface water that are a direct-contact human health concern.

VOCs. A variety of volatile and semi-volatile hydrocarbons have been reported in soil and groundwater investigated at former MGP sites (Table 1). For example, total VOCs in groundwater have been observed to exceed 400 mg/L at Wisconsin MGP sites (Dames and Moore 2000). The VOCs typically found to exceed DNR groundwater standards (Wisconsin Administrative Code *ch.* NR 140) are benzene, ethylbenzene, naphthalene, xylenes, styrene, and toluene.

Benzene and naphthalene are key VOC residuals. Of the VOCs found in airborne releases from excavation of MGP sites, benzene is the compound that typically drives public health concerns. The exposure limit of benzene is low enough to solely define the regulated toxicity of the MGP-related VOC mixture, and MGP air management decisions and action levels should focus on the potential for benzene release. Benzene, a by-product of coal coking or gas manufacturing processes, has both known human carcinogenicity (EPA class A) and high volatility (vapor pressure 75 mm Hg, 20°C) (ATSDR 1997).

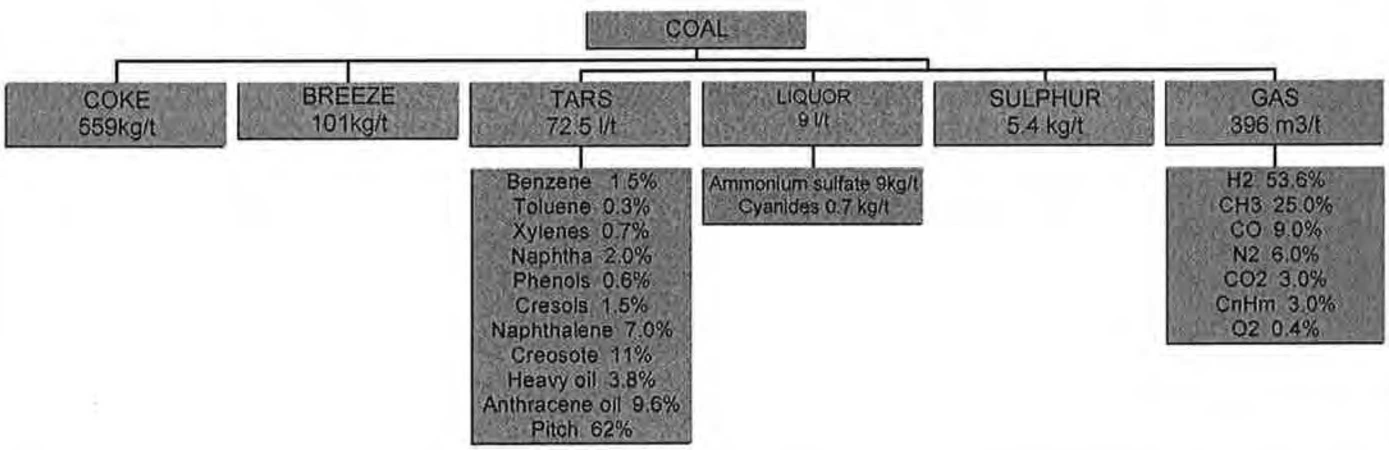
Naphthalene is another key compound of concern during MGP excavations. The volatility and toxicity of naphthalene are lower than benzene, although more similar to benzene than to other major VOCs (Table 2). The low odor threshold of naphthalene makes the presence of coal tar evident at low concentrations.

Monitoring naphthalene alongside VOCs requires additional work. Naphthalene is not detected quantitatively in EPA method TO-14/15 (SUMMA can samples; EPA 1999b), photo-ionization detectors (PID) calibrated for total VOCs, or particulate monitoring. In addition, losses during sampling render standard PUF plug sampling ineffective. Quantitative detection of naphthalene requires EPA method TO-13 (EPA 1999a) using a combination PUF/XAD2 collection medium or equivalent. Instantaneous readings of naphthalene can be made using a portable gas chromatograph with surface acoustic wave detector (GC/SAW) or another portable GC with a column suitable for naphthalene.

Particulates. Particulate matter, or PM, is the term for particles found in the air, including dust, dirt, soot, smoke, and liquid droplets (EPA, 2003a). Particulates, especially those from combustion sources, are solid mixtures of hydrocarbons, minerals, metals, and inorganics such as NOx and SOx. Particulates should be regarded not as inert dust but rather as chemical mixtures that have toxicological effects when inhaled. The high concentration of PAHs in MGP-contaminated soil makes the airborne dispersal of these waste soils a topic of interest and concern.

Potential sources of respirable (< 2.5μm: $PM_{2.5}$) and inhalable (< 10 μm: PM_{10}) particulates dispersed during MGP remediations include the handling of excavated PAH-contaminated soil, construction vehicle exhaust, construction road dust, PAH contaminated soil stockpiles, treated stockpiles, and potentially from malfunctioning thermal desorber stack emissions. Maintaining each of these sources to workplace and public health standards entails a combination of site management and air monitoring techniques. Perhaps most important is anticipating dry, windy conditions that disperse stockpiles. In Wisconsin, occasional problems have occurred around MGP sites where winds have dispersed particles and odors from pretreated stockpiles awaiting thermal desorption. In these cases, irritating odors in nearby buildings were resolved using surfactant controls on stockpiles and closing building openings where necessary. With experience, site managers can anticipate and prevent such problems. For example, at a summer MGP excavation in an urban residential location in Wisconsin, site managers found it prudent to cease excavation work during hot or windy afternoons to avoid potential air releases that would generate complaints from the public.

Figure 2. Product yield from coal gasification. (Adapted from Buckley 1983)



PAHs. Polycyclic aromatic hydrocarbons are a diverse group of hydrocarbons that comprise a large proportion of MGP wastes (Figure 2). PAHs are also a focal component of the particles targeted in the NAAQS. The PAHs commonly studied in the environmental literature and included in environmental reports from MGP sites are 2-6 ringed, with molecular weights in the range of 128-300 (Boström *et al.* 2002). The actual breadth of PAH structures present in MGP wastes is probably much greater (Hathaway 2002) if included are little-studied larger molecular weight structures, PAHs with side-chain substituents, and PAHs with sulfur- or nitrogen-containing rings. The tendency of PAHs to disperse ranges from semi-volatile (e.g. naphthalene, vapor pressure 0.08 mm Hg;), to non-volatile structures that are dispersed via surface adsorption to particulate matter. A number of PAHs are toxic following their oxidation to a corresponding reactive structure (ATSDR 1995, Boström *et al.* 2002). Activation to a reactive structure can occur through photooxidation in the case of skin contact, or metabolically in the case of ingestion or inhalation. Benzo(a)pyrene (B(a)P) is one of several PAHs that form reactive, tumorigenic metabolites. B(a)P is the prototypical PAH in toxic equivalency comparisons, although several authors assign higher toxic equivalency factors (TEF) to dibenzo[*a,h*]pyrene, dibenzo[*a,i*]pyrene, dibenzo[*a,l*]pyrene, and dibenze[*a,h*]anthracene (ATSDR 1995, Boström *et al.* 2002). Most of our lifetime exposure to PAHs occurs from ambient sources such as diesel exhaust; consequently PAHs are listed as one of the six major air pollutants targeted for reduction in ambient air by the national ambient air quality standards (NAAQS) of the clean air act (U.S. EPA 2003a). The current federal standard for particulate matter (PM_{10}) is 150 micrograms per cubic meter ($\mu g/m^3$) of air averaged over 24 hours and 50 $\mu g/m^3$ averaged over a one-year period. PAHs in excavated tars and tar-contaminated soils at MGP sites clearly have the potential to temporarily affect local air quality if allowed to disperse. All MGP remediation projects should include air management plans to control the dispersal of PAHs in excavated tars, tar-contaminated soil, and soil stockpiles awaiting treatment or transport.

Air standards for PAH particulates. Limiting the dispersion of PAHs is of primary concern during MGP remediation. However, as noted above, particulates released at MGP remediation sites are a mixture of substances representing the range of wastes and sources on site. The 150 $\mu g/m^3$ PM_{10} NAAQS is designed to address this variety of potential particulate sources. From a public health standpoint, the NAAQS is an appropriate air quality goal for the MGP site perimeter, and is more useful than, for example, a modification of the OSHA standards for carbon black, coal dust, or silica. A perimeter action level used to meet the NAAQS for particulates should be based on short-term exposure limit. A public health-based, short-term exposure limit for generic particulates is not widely used. Based on the ACGIH (2003) industrial recommendation of 10 mg/m^3 for inhalable particles and an uncertainty factor of 10 (for sensitive humans), a short term (15 minute) exposure limit of 1 mg/m^3 for inhalable (PM_{10}) particles is protective of public health. The action level for particulates that has been used at several MGP sites in Wisconsin is also 1 mg/m^3, although this action level was derived from standards for lead-contaminated soil (GZA, 2000). Although this action level for particulates has been empirically acceptable in most respects, it has the shortcoming of serving as a surrogate for monitoring naphthalene. Structurally, naphthalene is a PAH, but functionally is a VOC. Particulate measurements are not adequate to monitor naphthalene, a major component of MGP wastes, or other semi-volatile PAHs. See further discussion below under *Contaminants of Concern: VOCs.*

Metals. Metals, especially iron, are found in contaminated soils at MGP sites. Other metals found could include lead, arsenic, etc. The amount of these metals at MGP sites varies with the gas manufacturing process and with subsequent uses of these properties. These metals are nonvolatile but are potentially dispersed as inhalable and respirable particles. DHFS review of metal concentrations in soil data from MGP sites indicates that the public is adequately protected from metal exposure when dust control measures are followed and ambient air quality standards (PM_{10}) for particulates are met. Further public health review might be necessary at sites having extensive metal contamination from more recent activities.

Cyanides. Cyanide wastes at MGP sites exist mostly as stable iron cyanide complexes, such as ferric ferrocyanide, which are associated with oxide box wastes common to coal gas sites. A small percentage (< 5%; Luthy *et al.* 1994) of the total cyanide-containing waste is in the form of less stable metallo-cyanides and cyanide salts. The potential for free cyanides to be released from these materials into groundwater is a topic that has received both scientific and regulatory attention (Ghosh, *et al.* 1999a, 1999b; EPA 2003d). The release of cyanide to air at MGP sites is theoretically possible, but because such releases would occur from very slow dissociation of iron cyanides followed by rapid volatilization and dissipation, this is unlikely to be an exposure issue. DHFS has identified no public health concern from cyanide exposure to the general public at the site perimeter. Still, prudent management of worker safety at MGP sites suggests that cyanide should be monitored in air within the work zone when Prussian Blue soils are encountered.

Table 1. Composition of MGP wastes (From Gas Research Institute 1996). Chemicals in bold have been found to be an environmental or public health concern in soil, sediment, and groundwater at MGP sites in WI.

Inorganics	Metals	VOCs	Phenolics	PAHs
Ammonia	Aluminum	**Benzene**	Phenol	Acenaphthene
Cyanide	Antimony	**Ethyl**	Methyl	Acenaphthylene
Nitrate	Arsenic	**Benzene**	phenol	Anthracene
Sulfate	Barium	**Toluene**	Dimethyl	**Benzo(a)anthracene**
Sulfide	Cadmium	**Xylenes**	Phenol	**Benzo(a)pyrene**
Thiocyanates	Chromium	**Styrene**		**Benzo(b)fluoranthene**
	Copper			Benzo(g,h,i)perylene
	Iron			Benzo(k)fluoranthene
	Lead			**Chrysene**
	Manganese			**Dibenzo(a,h)anthracene**
	Mercury			Dibenzofuran
	Nickel			**Fluoranthene**
	Selenium			Fluorene
	Silver			**Indeno(1,2,3-cd)pyrene**
	Vanadium			**Naphthalene**
	Zinc			Phenanthrene
				Pyrene
				2-Methylnaphthalene

Sulfur compounds. Sulfur-containing compounds, produced by pyrolysis or combustion of coal, are common in soil and groundwater at MGP sites. This is especially true in oxide box wastes, which may contain 40% sulfur oxides (Luthy *et al.* 1994). Pulmonary damage from sulfur-containing materials, particularly sulfur dioxide (ATSDR MRL=10ppb), are well known (Kleinman 2003) but have not been well addressed as an air issue during MGP remediations. Sulfides (S^{2-} ; metal-sulfur compounds), sulfates (SO_4^{2-} ; compounds of oxygen and sulphur combined with one or more metals), and sulfites, where present, are predictably dispersed with soil and dust particles during MGP excavations. At this time, DHFS recommends that non-volatile sulfur compounds be managed in the context of NAAQS for particles discussed above.

Table 2. Toxicity, odor, volatility, and relative prevalence of major volatile compounds in air at MGP sites.

				Prevalence in air at one example MGP site[c]	
	Toxicity RBC ppb[a]	Odor threshold ppb[b]	Vapor pressure mmHg, 68F	Excavation (total volatiles= 4103 μg/m³)	Perimeter (total volatiles = 1117 μg/m³)
Benzene	10	61,000	75	21.7%	7.7%
Naphthalene	0.6	40	0.08	46.3%	6.3%
Xylenes	23	20,000	7	11.5%	56.4%
Toluene	106	1,600	21	8.3%	17%
Styrene	235	140	5	Not reported	Not reported
Ethylbenzene	230	100-600	7	11.9%	12.5%

[a]EPA, *Integrated Risk Information System, 2004.* Reference concentration chronic inhalation.
[b]AIHA 1989
[c]Collins *et al.* 1999

Developing Air Quality Goals and Action Levels

Recommended sentinel compounds. Many different volatile chemicals are present in MGP wastes, but on-site air management decisions are usually based on the monitoring of just a few of these (Collins *et al.* 1999). The choice of representative sentinel compounds in an air management plan should be based both on the risk imparted by a compound's prevalence and toxicity, as well as the analytical ability to detect these compounds. The odor threshold of particular VOCs also factors into their inclusion as a sentinel compound, since tar odors around MGP excavations speaks directly to public risk perception surrounding the remediation work. MGP projects often extrapolate from the fuel spill model, choosing the BTEX group (benzene, toluene, ethylbenzene, xylenes) as representative VOCs. Other candidate sentinel compounds should be considered, based on environmental assessment. For example, groundwater from an MGP test well in Wisconsin having 23,000 μg/L total VOCs included, as prevalent compounds, benzene (29%), naphthalene (31%), xylenes (17%), styrene (6%), and toluene (12%) (Dames and Moore 2000). Other PAHs, including acenaphthene, fluorene, anthracene, fluoranthene, and pyrene comprise a small percentage of volatile chemicals detectable in air (Collins *et al.* 1999). DHFS recommends choosing sentinel compounds at each remediation based on prior environmental assessment. However, based on prevalence, toxicity, volatility, and odor, benzene and naphthalene tend to define the volatile mixture around MGP sites (Table 2). Notably, the proportion of each of the major volatiles may not be the same in the excavation zone as at the perimeter (Table 2), indicating the need for separate air monitoring in the work zone and the perimeter. The minimum perimeter air monitoring recommended by DHFS would include total VOCs and benzene, using instruments sensitive to intermediate and maximum action levels defined in the site air management plan.

Development of action levels

Action levels vs. ambient air standards. During the review of air management plans (AMP) at MGP sites in Wisconsin, there has been discussion over the term "Action Level." There has also been much discussion of whether action levels should be created as policy benchmarks for MGP work. Some of this discussion is clarified by defining action levels as distinct from an air quality standard or guideline. For the purposes of public health, action levels proposed within an air management plan are a site management tool used to maintain existing air quality standards and guidelines at the unsecured perimeter. These ambient (daily and annual) air quality standards and guidelines already exist for common VOCs and particulates.

There is no single set of ambient air quality rules for compounds of concern at MGP sites. The ambient air goals recommended by DHFS are a combination of enforceable standards (*e.g.* National Ambient Air Quality Standards; NR 445 Ambient Air Standards) and non-enforceable guidelines (*e.g.* ATSDR Minimal Risk Level; EPA Risk-Based Concentration). The NAAQS for total particulates (PM_{10}, 24 hour average) is 0.150 mg/m^3. The guideline numbers for VOCs (Table 4) are presented where federal or state standards are absent. These guidelines are health-based environmental concentrations below which no harm is expected to the general public.

DHFS relies on existing ambient air standards and guidelines when asked to evaluate air monitoring plans and air monitoring data for MGP projects. The efficacy of action levels proposed in the AMP is ultimately defined by their ability to meet established standards and guidelines at the site perimeter. The action levels needed to protect public health could vary with the distance from the unsecured perimeter to the excavation, with the distance from the perimeter to stationary receptors such as residences or businesses unrelated to the MGP, with the time of year, and with the sensitivity and frequency of the monitoring program. Table 3 lists action levels that have been used successfully to maintain ambient air quality at several sites in Wisconsin. These action levels were used at sites using minimal air monitoring and sampling, and having low population density at the site perimeter. DHFS recommends that these action levels be used as a starting point in developing the site AMP. However, higher concentration action levels have been used (GZA 2003) to maintain air quality in urban residential settings, but using sophisticated real-time air monitoring techniques. In either case, DHFS would make the same recommendation: maintain 24-hour ambient air quality within existing health-based standards and guidelines, and further reduce nuisance odors as needed to meet community health needs and avoid odor complaints.

Two other points to consider in developing the AMP are first, that air management performance must be verified with time-weighted (8 or 24 hour) air sampling. Second, it is likely that during the excavation of coal tars, air quality will intermittently exceed the ambient air goals for periods that are brief enough to still maintain ambient air quality over the 24-hour cycle. Assuming the site will be managed to keep peak releases brief, these brief releases should still be held within some "maximum." Occupationally, this maximum would correspond to either a ceiling value or a 15-minute time-weighted average (TWA). But, no formal brief exposure standards exist for the general public that would correspond to the 15-minute occupational TWA. However, using an uncertainty factor of 10 for extrapolating from "normal" to "sensitive" humans, intermittent releases should not exceed, at the perimeter, one-tenth of the 15-minute time weighted average for either specific compounds or total VOCs. Table 4 contains recommended 15-minute maximum concentrations for perimeter air quality.

Air management plan action levels should provide immediate feedback needed to minimize air releases from the site. A prescribed set of site-specific responses should be proposed to accompany each action level. Table 3 lists a simple set of responses. Many AMPs use a more detailed decision tree or flow chart that integrates the various factors that enter into site management decisions (*e.g.* Lingle *et al.* 2000, Symonik *et al.* 1999). Environmental consultants and site managers are encouraged to develop and employ action levels that focus on achieving odor control rather than merely staying within short-term and 24-hour air standards.

DHFS recommends that air management plans use both intermediate and maximum action levels (Table 3). The response to exceeding an intermediate action level would be to monitor continuously and begin steps to mitigate air releases. Exceeding a maximum action level should result in immediately ceasing work until the air release is controlled. Continuing the excavation or material handling might require a shift in work strategy, such as more stringent air management techniques, or working on another part of the project until cooler or less windy conditions prevail. The use of intermediate action levels can be used to more closely anticipate releases and establish protocol for intermediate air management responses that will help avoid work stoppages.

Background exposure to VOCs. The development of action levels should consider that many MGP components have a background presence in ambient air. Background monitoring should be conducted prior to any excavation. The development of action levels should consider that public exposure VOC and PAH releases during excavation of MGP sites will rarely be zero due to the background presence of VOCs and PAHs. For example, in St. Paul, Minnesota (Sexton *et al.* 2004), personal air samplers placed on 71 non-smoking adults revealed that during normal daily activities, these adults were exposed to benzene (7.6 $\mu g/m^3$), toluene (30.3 $\mu g/m^3$), and xylenes (27.8 $\mu g/m^3$).

Occupational guidelines are inappropriate air quality goals at the MGP site perimeter. Another point occasionally requiring clarification is the gap between occupational and public health standards. Occupational standards are designed for exposures of workday duration to healthy, non-pregnant adults. Public health standards account for sensitive individuals and longer exposure duration. In some cases public health standards are extrapolated from occupational standards; in other cases they are based upon separate experimental models. Perimeter action levels should trigger steps to maintain public ambient air quality while occupational standards should be used for air management decisions in the worker breathing zone. Unadjusted TLVs for ambient air at or beyond the perimeter of any site are not sufficiently protective of public health, whether the site is in a residential or commercial setting.

Table 3. Recommended range of action levels and interventions for perimeter air quality at former manufactured gas plant excavations.

Air Monitoring Location	Recommended DHFS Action Level (ppm)	Recommended Interventions When Action Levels are Reached or Exceeded
VOCs at Site Perimeter	0.1 to 1.0 total VOCs	-worker breathing protection -test for benzene
Benzene at Site Perimeter	0.1 to 0.5 benzene	-halt site activities
Particulates at Site Perimeter	0.150 to 1.0 mg/m^3 total particulates	-initiate dust control measures

Air Monitoring Methods

Perimeter air monitoring should be a part of the work plan at every MGP remediation site. The site workplan should include an air sampling protocol including: 1) location of sampling stations, 2) the sampling interval, 3) target substances (or surrogate), 4) detection limit of target substances, 5) the action level and planned response for each target substance, 6) meteorologic conditions concurrent with sampling.

Air monitoring techniques for the MGP site perimeter. Although perimeter air monitoring should be a part of the work plan at every MGP remediation site, there is no single air monitoring approach best suited or appropriate for all sites. A number of methods are available, ranging from automated real-time gas chromatography to hand-held devices such as photoionization detectors. Automated gas chromatography has been used effectively to measure sentinel compounds around MGP sites and provide results in continuous 15 minute cycles. This feedback effectively teaches project officers how to manage their sites to avoid air emissions that affect both site workers and the off-site public. Real time air monitoring is particularly useful at sites that are technically complex and densely populated. Because of the cost and complexity of such a system, hand-held instruments may be appropriate at sites that are small, isolated, or where the duration of the excavation is relatively brief. To be useful for air monitoring at the site perimeter, the detection limit of the method used should be less than the intermediate action level agreed upon in the site Air Monitoring Plan. Alternatively the detection limit should be 2.4% of the occupational 8-hour time-weighted average for the substance being monitored, where 2.4% extrapolates from work week to full time exposure and incorporates a 10-fold uncertainty factor (40 hr/160 hr x 1/10 = 2.4%).

Table 4. DHFS-recommended 24-hour and short-term perimeter air quality values for MGP remediation sites.

	Acceptable 24-hour average concentration (ppb)	DHFS-Recommended Maximum	
		15 minute (ppb) [d]	Peak (ppb) [f]
Benzene	10 [a]	500	2,500
Naphthalene	20 [b]	15,000	*
Xylenes	23 [a]	15,000	*
Toluene	94 [a]	30,000	50,000
Styrene	235 [a]	10,000	20,000
Ethylbenzene	230 [a]	12,000	*
PM_{10}	0.150 mg/m^3 [c]	1.0 mg/m^3 [e]	*

[a] U.S. EPA reference concentration (RfC) for lifetime exposure.
[b] DHFS-derived 14-day acute exposure.
[c] National ambient air-quality standard for PM_{10} (particulate matter < 10 um).
[d] One-tenth of corresponding U.S. Occupational Safety and Health Administration value except where specified.
[e] ACGIH
[f] One-tenth of corresponding American Conference of Governmental Industrial Hygienists value.
*Occupational value not available.
ppb: parts per million

Instrumentation

Drager tubes. Drager tubes and similar single-use chemical detection tubes have limited application for perimeter air monitoring at MGP sites. Because of limited sensitivity, short shelf life, and high variability, they are best used semi-quantitatively, such as to determine if a specific contaminant is present. They are not recommended to measure the air contaminant concentrations at the site perimeter needed for making action level decisions (GRI 1996). Additional analysis is needed for any positive contaminant hit on a Draeger Tube. Detection limits published for compound-specific Draeger Tubes are: benzene (0.5 ppm), toluene (50 ppm), xylenes (10 ppm), styrene (1 ppm) (AFC International Inc. 2003. http://www.afcintl.com/tubeac.htm)

Photo-Ionization Detector. Hand-held photo-ionization dectectors (PID) capable of detecting 1 ppb total organic vapors or 100 ppb benzene are commercially available, and are more sensitive and easier to use that gas detection tubes. Of particular note are benzene-specific PIDs. Because benzene at low concentrations (50 ppb; Table 3) often defines the toxicity of the MGP-related VOC mixture, low-concentration field screening for both benzene and total VOCs is recommended

Laboratory analysis using SUMMA canister samples. Up-wind and down-wind ambient air sampling for VOCs using EPA Method TO-14 or TO-15 from SUMMA canisters samples (EPA 1999b) at locations where site perimeter monitoring with a PID detects greater than 0.5 total VOCs. In most cases, an up-wind and down-wind sample should be collected for VOCs at least once every three days regardless of the PID measurements.

Particle monitoring. Consistent with monitoring VOCs, monitoring particulates should employ a combination of real-time techniques for making action level decisions and time weighted techniques to verify compliance with NAAQS. A variety of separation and capture techniques are available for time-weighted sampling, including cyclonic separators, cascade impactors, and filters. Portable and semi-portable particle meters are available for instantaneous readings. An issue responsible parties should be aware of is the current shift from PM_{10} to $PM_{2.5}$ as the NAAQS. At this time, DHFS and DNR recommend continued use of the Federal Reference Method (FRPS 1287-065 or equivalent; U.S. EPA 2003c) for PM_{10} as more appropriate for construction-phase activities at MGP sites, and continued use of the 1 mg/m^3 action level.

Portable GC/MS. Gas chromatography/mass spectroscopy (GC/MS) has seen increasing use during MGP remediations. Semi-portable automated GC/MS systems have been developed that send results, over a 15 minute cycle, to a central monitoring location (GZA, 2000). Several GC/MS stations, placed around the perimeter of an MGP remediation, are used to simultaneously monitor an entire site, and to provide real-time feedback for making air management decisions. This system is expensive to employ, and the overall air mitigation performance is less than that of an enclosure. However, for sites where stringent air management is needed, but an enclosure is not possible, this is a useful method. GC/MS is also available in portable suitcase-sized units. A useful application of portable GC/MS is to provide sensitive field screening for VOCs in neighborhoods where there have been odor complaints. At some sites, local vagaries in wind patterns raise the possibility that air releases are carried to locations not predicted by perimeter air monitoring. Portable VOC detection using GC/MS is a sensitive means to provide verification and reassurance to the public.

Gas Chromatography with Surface Acoustic Wave detector (GC/SAW) is a portable GC method that is sensitive to naphthalene and larger molecular weight volatiles and semi-volatiles. Field-portable GC/SAW instruments (e.g. zNose, Electronic Sensor Technology, Newbury Park, CA) have being promoted for use during MGP remediations (GEI 2004).

Mitigation Techniques

Seasonal timing. Seasonal timing of an MGP excavation can have an important effect on air management strategies. In Wisconsin, as in other temperate regions, excavating MGP sites during cold weather simplifies many of the public health issues related to the remediation work. During cold weather, exposed hydrocarbons are less volatile, neighbors keep windows and doors closed, and there is generally less foot traffic. Direct benefits to site managers include fewer odor complaints and less need for foam and surfactants for odor control. DHFS recognizes there are problems with extreme cold weather work, including machinery failure, work stoppages, and ice-fouled water lines. Odor control techniques become more complicated when overspray from surfactants or misting systems create icy roads, and when plastic sheeting becomes stiff and brittle. Of all of these factors, DHFS believes that the simple fact that doors and windows are closed in winter has the greatest effect on minimizing public perception of the odor issue, thereby increasing public acceptance of MGP remediation projects.

Dust and odor control methods. The use of dust and odor control methods at MGP sites is commonplace and includes some combination of water, physical barriers such as plastic sheeting, wind screens, surfactants, and other chemical coatings such as foams (GEI 1996, sec. 12.4.2; U.S. EPA. 2003b). Perimeter misting systems supplemented with odor-masking perfumes have recently been used in Wisconsin. Scents added to the mist mask low concentrations of objectionable VOCs, but do not remove these VOCs from air. The mist does prevent dispersion of particulates, but only to the extent that precipitation follows interception. During hot or windy conditions, dispersion may still occur. Control of releases from source areas is still the primary mitigation technique. These various techniques and systems vary in cost and applicability. Ultimately, their effective use depends on the experience and judgement of on-site managers.

Excavation methods are another technique for reducing dust and odors. Most often cited is minimizing the excavation face combined with odor-encapsulating foam. A special form of excavation is Cassion-drilling, in which large-diameter drills (6 feet or more) bring up contaminated soil which can be immediately stabilized with cement and replaced in the drill hole. In terms of causing air releases, this technique presents the contrast of vigorously churned material, which enhances release, combined with a minimal and intermittent excavation face that limits air releases. At this time it is unclear how much air monitoring and dust and odor control is needed to ensure public safety when Cassion drilling is used.

Enclosure methods. Many former MGPs were located on sites that now see urban-density commercial or residential uses. Public acceptance of excavation work at such sites may require the most stringent methods to control air emissions. A temporary structure, combined with an air purification system, is often the most effective way to control emissions. Temporary structures can also effectively enclose certain operations, such as the on-site oxidative treatment of coal tar, which would not otherwise be possible. Temporary structures have several disadvantages, such as rental and installation costs, scheduling constraints, limited interior space, and requirements for respiratory protection (Pluhar 2004). During the limited use of enclosures at MGP sites in Wisconsin, DHFS has seen that air releases of VOCs and particulates have been controlled to within public health guidelines, but that coal tar odors can still be irritating to adjacent residents (DHFS 2002). Although the aim of using enclosures is to preclude the displacement of sensitive residents, project managers are advised to carefully evaluate whether a proposed enclosure will actually meet community needs. More recent developments in enclosure methods include "air lock" doorways that address a key weakness in enclosure design (Pluhar 2004). DHFS will review field performance reports of improved enclosure designs as they become available.

Establishing the on-site decision making process

Action Level response plan. Where MGP work is in close proximity to residences, odor and health complaints from the public should be anticipated. The health and safety plan or air management plan for each MGP remediation project should include contingency plans of actions that can be taken to intervene and prevent inhalation exposures to the public.

Contingency plan. MGP remediation consultants should anticipate that on certain days, it may not be possible to maintain ambient air quality with the tools they have available. In addition to stated actions when intermediate and maximum action levels are exceeded, the air monitoring plan for each site should include discussion of such contingencies. Contingencies might range from rescheduling site actions to offering temporary relocation of residents.

Summary

This guidance was developed both to protect public health around MGP remediation projects and to help those projects proceed smoothly. One key to effective air management and public outreach at MGP remediation sites is collaboration among public health, environmental agencies, and responsible parties. DHFS experience at MGP sites in Wisconsin was used to illustrate how to anticipate community health needs and to create partnerships with state and local health agencies during the course of the remediation. Because the amount of air management and public outreach needed varies with each site, this guidance avoids being overly prescriptive. However, in order for health departments to approach the community with credibility, some minimum air management and community health goals are recommended.

Conclusions

- Air management plans at MGP remediations in WI have been largely successful in meeting 24-hour air standards and guidelines for ambient air.
- Even where 24-hour health-based standards and guidelines are met, tar odors are typically evident.
- The control of tar odors plays an important role in the public's acceptance of the MGP remediation project.
- At sensitive locations, building public acceptance for an MGP project entails a combination of public outreach efforts and a stringent air management plan.

Recommendations

- Air quality at the unsecured perimeter of MGP remediation sites should meet existing public health-based 24-hour standards and guidelines for ambient air.
- Site air management plans, including monitoring and mitigation methods, and action levels, should be designed to protect perimeter air quality.
- Neighbors of MGP excavations should be able to avoid tar odors within their homes with doors and windows closed. Meeting this goal should focus on site management, but might also entail special accommodations for neighbors.
- At locations when MGP work will affect the public, detailed plans should be developed for risk communication, accepting and responding to complaints from the public, and accommodating individuals with special needs. Developing these plans usually entails discussion and advance agreement among major stakeholders.

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Abbreviations used. VOC: volatile organic carbon. PAH: polycyclic aromatic hydrocarbon. ATSDR: Federal Agency for Toxic Substances and Disease Registry. MCL: ATSDR's Maximum contaminant Level. NAAQS: National Ambient Air Quality Standard. GC/MS: gas chromatography/mass spectroscopy. PM: particulate matter.

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May 5, 2011
File No. 05.0043654.00-C

Mr. Joseph Martella
Rhode Island Department of Environmental Management (RIDEM)
Office of Waste Management
235 Promenade Street
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Re: Air Quality Monitoring
Natural Gas Regulator Station Upgrade Project
Former Tidewater Facility
Pawtucket, Rhode Island

Dear Mr. Martella:

On behalf of the Narragansett Electric Company d/b/a National Grid (National Grid), GZA GeoEnvironmental, Inc. (GZA) has prepared this letter to summarize plans for Air Quality Monitoring during the upcoming Natural Gas Regulator Station Upgrade project. This summary is based on our submittal related to the potential applicability of Air Pollution Control Regulation No. 9 and air monitoring for this activity dated April 19, 2011, and the Department's comments dated April 22, 2011.

Potential emissions modeling performed by GZA and the Department indicated that all potential emissions from this activity are below the Minimum Quantity thresholds of Regulation No. 9 and therefore a preconstruction permit is not required. Air monitoring during this activity will be conducted consistent with the two tiered strategy presented in our April 19, 2011 Air Quality Monitoring Plan (AQMP) with the following modifications based on the Department's comments:

- Consistent with the Department's recommendations, we will use an action level of 0.1 ppm above background for both real time monitoring instruments (Total Volatile Organic Compounds and benzene). This lower range action level will be considered exceeded in the event readings in excess of 0.1 ppm are sustained for a period of five minutes at the property line. This time period is necessary to account for potential instrument interference associated with ambient conditions. In the unlikely event levels significantly exceeding 0.1 ppm are detected above background, the full five minutes will not be waited prior to initiating mitigating measures/engineered controls;

- As described in our April 19, 2011 submittal, polynuclear aromatic hydrocarbon (PAH) concentrations in the ten soil samples collected in the area of the regulator station upgrades were non-detect for naphthalene. Based on the predictive modeling, these analytical results, and our visual and olfactory observations during recent investigations performed in this area of the site, we do not believe that real-time monitoring for naphthalene is warranted and therefore, as described in the AQMP, the zNose® will not be used for this particular activity. The previous issue related to naphthalene originated from sludges contained within the former gasholders. The materials to be managed associated with this limited excavation project have been characterized as urban fill. Per the Department's comments, National Grid will evaluate future projects at the Tidewater site on a case-by-case basis to determine the appropriate air quality monitoring strategy, which could include the use of the zNose®.

- Consistent with the above discussion related to the relatively low levels of PAHs detected in the soils samples from the regulator station area, monitoring for particle bound PAHs is not warranted. We will monitor for respirable particulate matter as described in the AQMP.

We appreciate the Department's timely review of our April 19, 2011 submittal. The natural gas regulator station upgrade project is currently scheduled to commence on May 23, 2011. As we have discussed previously, the earthwork associated with this upgrade project will take approximately 2 weeks to complete.

Please feel free to contact either of the undersigned or Michele Leone at 781-907-3651 should you have any questions.

Very truly yours,

GZA GEOENVIRONMENTAL, INC.

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