

USPS Pontiac PDC SVE Vent/Membrane System Design Approach
USPS Project No. Y82441

The initial Methane SVE Vent/Membrane System 30% Design submittal provided by Arcadis Giffels consisted of a typical SVE system designed to operate in an active mode only. The review of this design approach by USPS's design review engineer, URS, Inc., resulted in nineteen comments including the request for passive venting system calculations.

The Mannik & Smith Group (MSG) was requested by Walbridge-Teng to replace Arcadis to continue with the design due to extraneous matters. As an initial step in its design approach, MSG identified a lack of available methane data for the site. Based on this lack of information and the well-known fact that methane vent/membrane systems are routinely required in certain areas of California due to the natural release of methane from geologic formations and from the release of methane from LNAPL areas (from oil wells, etc.) and that numerous municipalities in California have developed empirical SVE Vent/Membrane System designs using minimal available methane concentration data, MSG submitted 30% Design Review responses to URS indicating that they would use the Los Angeles Department of Building and Safety (LADBS) empirical design approach.

Based on URS agreement with this design approach per URS responses to MSG's second set of 30% design review comments, MSG moved forward with the LADBS design approach as a template for the site SVE Vent/Membrane System design.

The LADBS design approach provides five site design levels with Level V being the most conservative in terms of the approach and requirements. Per the LADBS design approach, a Level V design is used when a Methane Soils Gas Testing Program identifies methane at concentrations above 12,500 ppm at all encountered methane pressures or when methane soils gas information is not available (assumption by MSG).

Methane data was subsequently submitted to MSG from two sources. The "Summary of Environmental Conditions" document prepared by URS and dated September 2, 2005 was provided to MSG by Robert Healey of URS on May 5, 2006 via e-mail and the "AIR Methane Investigation Summary" prepared by Beth Landale of CRA dated July 15, 2005 was provided to MSG from John McKenna of BBL, Inc. (via Charles Poat of Walbridge Teng) on May 8, 2006.

Section 2.10 "Methane" of the URS document provides only a cursory summary of the methane gas issues on the site and does not provide specific information with regard to concentrations and associated locations whereas the CRA document provides specific methane gas monitoring data information including methane pressure and concentration data for numerous gas probes located throughout the LNAPL-impacted areas (including LNAPL Areas 1, 2, 3, 7, 9, 10) and within the proposed footprint of the USPS PDC facility.

A review of the CRA document reveals that for the eight monitoring locations within the building footprint the methane pressure and concentrations (in terms of percent volume in air), 83% of the readings obtained were zero, 13.6% of the readings were at 0.2 or 0.3% methane and one reading (of the 30 obtained) was at 3.3%. Additionally, the readings where methane was detected were not confined to one monitoring location. Rather, methane was detected at five of six of the monitoring locations during one sampling event which occurred on July 1, 2005. Methane was not detected at any of these six monitoring locations on all of the other sampling events which occurred from June 28, 2005 through July 8, 2005.

Based on this information, MSG prepared a “Methane Venting System Review” design document which provides the design basis for the Methane SVE Vent/Membrane System Design. This design document is provided in Attachment 1. In summary, the document includes the following:

- provides an overview and summary of our design approach,
- identifies the base method we have chosen for design (i.e. the LADBS design standards),
- provides a review of the existing methane investigation data,
- describes our site specific design approach based upon the base (LADBS) method and site specific data with information on the passive system expansion potential and the active system modification potential, and
- provides a potential gas generation and design system capacity.

The potential gas generation estimated was 22.5 pounds per year. However, this theoretical determination does not take into account site specific features such as the three feet (on average) clay cap that now exists over the building footprint. This clay cap was constructed as a result of the need to place and compact structural fill (to a density of 95% of the materials theoretical maximum dry density obtained per ASTM D1557) to achieve building subgrade design elevations. The material used to achieve this grade was clay fill obtained from the on-site stockpile.

The methane data recently provided to MSG, along with the methane generation calculations suggest that the site design level in accordance with LADBS design standards is at greatest a Level I site design level. At this design level, pressure sensors below the impervious membrane and a mechanical extraction system are not required for the sub-slab vent system. Details on this approach are provided in Attachment 1.

Parking Lot Methane SVE Passive Vent System Design

MSG has designed the parking lot methane SVE Passive Vent System in accordance with LADBS design standards. A copy of the LADBS design standards is included with the Methane Venting System Review design document contained in Attachment 1. The exception to this is that vent pipes will be spaced at a distance slightly greater than 100 feet due to locations available to place the vent pipes. MSG is proposing to vent the methane via standard fiberglass flagpoles modified such that the horizontal, perforated

pipes will tie in to the vertical flagpole pipe below grade. Details on this approach are provided in the design plans.

The LADBS design standards provide several options for venting paved areas over 5,000 square feet in area and within 15 feet of the exterior wall of a commercial, industrial, etc. building. These options include installing landscaping areas immediately adjacent to the building exterior walls at least two feet wide covering at least 80% of the building perimeter, installing vents in accordance with their standard plans, or not requiring venting at all if the site qualifies for Site Design Level I, II or III. Thus, passive venting of the paved areas to the west of the proposed building (within LNAPL Area #9) will not be performed since this area is nominal compared to the landscaped areas surrounding it. These landscaped areas will allow for the natural venting of the methane.

Building Methane SVE Passive/Active Vent/Barrier System Design

As previously noted, the MSG design review is provided in Attachment 1. Based on this review, the methane SVE Passive/Active Vent/Barrier System will consist of a sub-slab vent system designed in accordance with LADBS design standards.

Due to the lack of methane detected within the building footprint (per the CRA report), the determination that methane is not migrating horizontally towards the proposed building footprint from the LNAPL areas where methane is detected (per the CRA report), the construction of what essentially amounts to a clay cap several feet thick below the building footprint, i.e. the placement and compaction of structural fill/clay from the on-site surcharge stockpile at a compaction effort of 95% of the material's theoretical maximum dry density as determined by ASTM D1557 to achieve the proposed subgrade design elevation), the identification of a maximum Level I design criteria applicable to the building, the system has been designed to allow for minimal upfront capital investment by USPS but with the flexibility to be modified in the future if methane is detected at elevated concentrations at isolated locations in the sub-slab vent collection system.

The system has been designed such that vent risers spaced at 100 foot intervals within each collection pipe (per LADBS standards) will be stubbed one foot above the on-grade slab. The risers will be located within the webs of building columns to ensure minimum interference with USPS operations. Each riser will contain a lab cock such that methane concentrations can be manually determined with one of the two portable gas meters which are required to be provided to USPS per Part 2.2.21 of Attachment 16 within the Solicitation.

Delphian infrared (IR) methane remediators will be installed in the vent riser stubs (note: stub heights will be higher due to this equipment) at one location within each quarter or quadrant of the building (for a total of four (4)). These will provide for the means to continuously track and monitor the buildup of methane in the sub-slab vent layer. Additionally, IR sensors will be placed in selected rooms within the proposed building to

monitor conditions within the interior work space. The control panel for the IR remediators will be located in a yet-to-be determined location within the building.

Based on the unlikely buildup of methane within this layer, the cast iron risers could then be modified to function as passive roof vents (see plans for details) or as active collection system roof vents. The passive vents become active with the installation of in-line blowers such as CBI Series, centrifugal blowers manufactured by FanAm, Inc. These blowers can be constructed with explosion proof motors upon request and can be installed in-line with the use of a flex connector hosing. Air flow would be dependant on the model selected. For example, the CBI 160 series fan is capable of a maximum airflow of 900 cfm.

Methane Venting System Review
United States Postal Service - Northeast Metro Processing and Distribution Center
USPS Project No. Y82441

Prepared By: *JSB*

QC Reviewed By: *TEP 5/19/06*

Date: May 15, 2006

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Overview and Summary

A methane venting system is planned for the United States Postal Service (USPS) Northeast Metro Processing and Distribution Center (USPS Project No. Y82441) in Pontiac, MI. This review summarizes qualitative evaluation of the proposed system. It presents a logical, step-wise approach to system design development. The review incorporates verification and comparison of design elements to assure an optimized design. The review includes 4 primary elements and is formatted as listed below.

I. Identification of Base Method

II. Review of Existing Methane Investigation Data

III. Design Site Specific System Based Upon Base Method and Site Specific Data

A. Passive System Expansion Potential

B. Active System Modification Potential

IV. Potential Gas Generation and Design System Capacity

In summary, the system proposed provides an effective means to mitigate potential methane gas migration into the proposed facility. In addition, the system is readily expandable to increase the passive venting capacity and it is convertible to an active venting system.

I. Identification of Base Method

A review was completed to identify local requirements or ordinances to address potential methane generation beneath buildings and recommended or required mitigation. A review of City of Pontiac and Macomb County requirements was completed and no applicable or relevant requirements were identified. A more global search was conducted to identify potential recommendations or requirements for methane mitigation. The Methane Hazard Mitigation Standard Plan (MHMSP) from the City of Los Angeles Building Code were identified as a firm basis to develop a site specific system.

The MHMSP includes recommendations and details for mitigation requirements for new buildings. The overall intent of the MHMSP is to promote public safety and welfare by mitigating potential methane intrusion. The recommendations and details include passive system venting, active system venting and miscellaneous systems. Direct relation of actual methane monitoring data to design recommendations is provided within this standard.

For reference, a copy of the MHMSP standard follows.

II. Review of Existing Methane Investigation Data

On May 9, the July 15, 2005, Area of Industrial Redevelopment (AIR) Methane Investigation Summary prepared by Encore Environmental Consortium, LLC (EEC) was provided. This summary includes methane and pressure data obtained at the project site from March through July 2005. This data is summarized on the following data sheet and on the subsequent figure. EEC field monitoring results showed methane data that varied widely. At some locations elevated methane levels, up to 70% by volume, were encountered. However, many of the methane readings obtained were at or near zero. The lower and the upper explosive limit for methane are 5% and 15%, respectively.

The field data provided showed essentially twenty monitoring points. Of these twenty, eight monitoring points were located within and twelve were located outside the proposed building footprint. Review and evaluation of the data is presented on the following Summary of Methane Investigation Data table and accompanying drawing and summarized below.

First, seven of the eight monitoring points within the proposed building footprint exhibited extremely low levels, averaging below 0.1% methane. The lone remaining point within the proposed building footprint exhibited an average methane level of 1.2%. This point was associated with LNAPL Area No. 3. It should be noted that 1.2% is below a common first point of notification for a methane monitor, 25% of LEL, which is equivalent to 1.25% methane.

The twelve monitoring points outside of the proposed building footprint displayed higher methane levels. These points were primarily located to the west and north of the proposed building footprint. These monitoring points were associated with LNAPL Area Nos. 1, 3, 7, 9 and 10.

One of these twelve monitoring points was located approximately 30 feet west of the proposed building footprint. This monitoring point exhibited no notable methane.

One of these twelve monitoring points was located within LNAPL Area No. 7, which varies from approximately 230 to 330 feet west of the proposed building footprint. This point exhibited low methane levels, average methane readings were below 0.1%.

Three of these twelve monitoring points were located within the LNAPL Area No. 1, which varies from approximately 250 to 900 feet west of the proposed building footprint. These points exhibited average methane readings from approximately 2% to 9%.

Two of these twelve monitoring points were located within the LNAPL Area No. 9, which varies from approximately 25 to 250 feet west of the proposed building footprint. Both of these monitoring points were approximately 180 feet west of the proposed building footprint. These points exhibited average methane readings from approximately 27% to 48%. This area is located west of LNAPL Area No. 3.

Three of these twelve monitoring points were associated with LNAPL Area No. 10, which varies from approximately 250 to 580 feet west of the proposed building footprint and is immediately west of LNAPL Area No. 9. The one point within LNAPL Area No. 10, which was approximately 530 feet west of the proposed building footprint, exhibited average methane readings of approximately 63%. The two points outside of LNAPL Area No. 10, to the north and south, exhibited average methane readings from 0.1% to 4%.

Two of these twelve monitoring points were associated with LNAPL Area No. 3 outside of the building footprint. The one point within LNAP Area No. 3, which was approximately 130 feet north of the proposed building footprint, exhibited average methane readings of approximately 32%. The one points outside of LNAPL Area No. 3, which was approximately 230 feet north of the proposed building footprint, exhibited average methane readings of approximately 0.1%.

A reference copy of the July 15, 2005, Area of Industrial Redevelopment (AIR) Methane Investigation Summary prepared by Encore Environmental Consortium, LLC is included with this review.

METHANE HAZARD MITIGATION STANDARD PLAN

I. PURPOSE

This Methane Hazard Mitigation Standard Plan provides standard details and specifications that may be used to comply with the requirements of the Methane Seepage Regulations of Division 71 of the Los Angeles Building Code. The intent of methane mitigation systems described in this plan is to promote public safety and welfare by controlling methane intrusion emanating from geologic formations. These systems are not intended to regulate flammable vapors that may originate in and propagate from other sources, which include, but are not limited to, ruptured hazardous material transmission lines, underground atmospheric tanks, or similar installations.

II. HOW TO USE THIS STANDARD PLAN

To use this Standard Plan select either of the following:

1. Avoid Methane Soils Gas Site Testing and construct components for Site Design Level V shown on Tables 1A (Methane Zone) or 1B (Methane Buffer Zone) on Sheet 4.
2. Avoid Methane Soil Gas Site Testing by designing the building using one of the exceptions to Table 1A or 1B under Section IV B 2, 3 or 4 of this Standard Plan.
3. Conduct Methane Soils gas testing, complete Form 1 on sheet 3, and construct components listed in Tables 1A or 1B on Sheet 4.

NOTE: Identify the required Methane Hazard Mitigation components with a "circle" around the appropriate exception under Section IV B (Sheet 1) or the respective column in Tables 1A or 1B (Sheet 4).

III. GENERAL REQUIREMENTS

CODES:

All work shall be in compliance with the current version of the Los Angeles Building Code and policies of the Department of Building and Safety, and all applicable County, State, and Federal Codes.

INSPECTION:

All work, requiring inspection by the Department of Building and Safety, shall be available to the inspector prior to being covered by subsequent work.

IV. MITIGATION REQUIREMENTS

A. NEW BUILDINGS

All new buildings and paved areas located in a Methane Zone or Methane Buffer Zone shall comply with this Standard Plan and Division 71 of the Building Code.

B. EXCEPTIONS TO TABLE 1A and 1B

The provisions of the Building Code, Section 7104.3 are exceptions to the construction requirements of Table 1A and 1B based on the configuration of the building construction. The following exceptions may be used in lieu of full compliance with Tables 1A and 1B. For further information regarding the design of methane mitigation components, see Section V of this Standard Plan.

1. Narrow Buildings.

Narrow Building is a building that has a width less than 50 feet, a footprint of less than 50,000 square feet and having a minimum 2-foot wide landscaped area immediately adjacent to the exterior wall for at least 50 percent of the perimeter of the building.

Narrow Buildings are still required to provide the methane mitigation requirements of Table 1A and 1B, except that if Pressure Sensors below the Impervious Membrane are not required per Table 1A and 1B, then they may be installed in lieu of a Gas Detection System and Mechanical Ventilation. A minimum of 2 feet wide landscaped area shall be used to free any subsurface methane gas trapped underneath the building into the atmosphere.

2. Buildings with Raised Floor Construction.

Provide all of the following methane mitigation components in lieu of the requirements in Table 1A and 1B.

- a. The utilities shall be installed with Trench Dams, Detail 16 on Sheet 8, and Cable or Conduit Seal Fittings, Detail 8 on Sheet 7.
- b. Four inch (4") thick gravel blanket shall be installed under and around the elevator pits, when there is an elevator pit constructed in the building.
- c. In lieu of the underfloor ventilation requirements of The Building Code, Section 7104.3.2, the underfloor ventilation shall be provided using all of the following:
 - i. An approved mechanical ventilation system which is equivalent to providing one complete air change in the underfloor space once every 20 minutes, or
 - ii. An under-floor system with a clear height above grade of at least 12 inches to girder, 18 inches to floor joist, and 24 inches to structural floors.
 - iii. Openings for underfloor area or crawl space ventilation shall be located less than 6 inches below the bottom of the floor joists. The openings shall be located to provide cross ventilation and shall be the larger of:
 - Openings of not less than 1.5 square feet for each 25 linear feet of exterior wall; or
 - Openings shall be 1% of underfloor area.
 - iv. Openings for underfloor area or crawl space ventilation shall be approximately equally distributed along the length of at least two opposite sides of the building. They shall be covered with corrosion-resistant wire mesh with mesh openings not less than 1/4 inch nor greater than 1/2 inch in dimension.

3. Buildings with Natural Ventilation

- a. Buildings with Natural Ventilation are buildings with Unobstructed Openings or an opening with a wind-assisted system in exterior walls. Unobstructed Openings for Natural Ventilation shall be evenly spaced to prevent the accumulation of methane gases within the building and shall be constructed as follows:
 - i. Unobstructed Openings shall be permanently affixed in the open position.
 - ii. Unobstructed Openings shall be free of obstructions, except for screens of wire mesh with not less than 1/4", or wind driven turbines.
 - iii. The aggregate size of Unobstructed Openings providing Natural Ventilation for an enclosed space shall be the larger of:
 - 25% of total floor area of the lowest level of the building, or
 - 25% of the total perimeter wall area of the lowest level of the building.
 - iv. Unobstructed Openings shall be located in walls or roofs to facilitate natural venting of methane gas to the atmosphere.
 - v. Locate uniformly distributed Unobstructed Openings on two or more exterior sides to provide cross ventilation as close to corners as practical.
 - vi. Unobstructed Openings shall comply with the provisions of the Los Angeles Building Code including location on property, openings adjacent to stairways and courts.
 - a maximum of 6 inches below roof or ceiling joists in the space to be ventilated,
 - no more than 50 feet from any point within the building and
 - to provide cross ventilation utilizing either of the following:
 1. two opposing sides of the building or space to provide cross ventilation.
 2. two adjacent sides where at least 50% of the required area of vents are centered a distance of one half the diagonal of the space being ventilated.
 - vii. Unobstructed Openings in walls shall be located:
 - to remove gases from the highest point in the room or enclosed space,
 - at a minimum of two positions a maximum of 50 feet on center and
 - evenly distributed throughout the enclosed space.
- b. In lieu of the requirements of Table 1A and 1B, buildings with Natural Ventilation, such as, restrooms, gazebos, barns, attendant stations and other similar accessory buildings located in parks or buildings with lowest levels closest to grade having Group S, Division 2, 3 or 4 occupancy, or detached buildings of Group U, Division 1 occupancy and Unenclosed Buildings shall be constructed with utilities installed with Trench Dams and either Conduit Seal Fittings or Cable Seals Fittings.

4. Enclosed Rooms or Spaces within Building.

Individual enclosed rooms or enclosed spaces with floor area less than 2,000 square feet may be exempt from providing the Active System as required by Table 1A and 1B, provided the vent openings comply with all of the following:

- a. Vent openings are Unobstructed Openings, except screens of wire mesh at least 1/4 inch or wind driven turbines on the roof shall be permitted.
- b. The aggregate size of vent openings shall be the larger of either five percent of the total floor area of the room or the area of enclosed space, or ten percent of the area of walls on the perimeter of the room or enclosed space.
- c. The vent openings shall be located to prevent the accumulation of methane gases within the room or enclosed space.
- d. The top of the vent opening shall be located not more than 12 inches below roof joists or ceiling joists if located in a wall of a building.
- e. The vent openings shall be located on either two opposite walls or two adjacent walls of the room or enclosed space if located in a wall of a building.
- f. The vent openings shall be located no more than 50 feet from any point within the room or enclosed space.
- g. When using wind driven turbine, the area of the vent opening shall be calculated by the area of the opening at the attachment of the wind driven turbine at the roof.
- h. When the vent opening is located in a wall of an adjoining room, then the adjoining room shall be constructed of either an Active System, or have Natural Ventilation as described in Subsection 3 above (Buildings with Natural Ventilation.)

5. Single Family Dwellings and Buildings Accessory to Single Family Dwellings, some or all of the following may be used in lieu of the requirements of Table 1A and 1B:

- a. When Pressure Sensors below the Impervious Membrane are not required by Table 1A and 1B, Pressure Sensors below the Impervious Membrane may be installed in lieu of Gas Detection System and Mechanical Ventilation.

- b. Single Station Gas Detectors with battery back up may be installed in lieu of an Alarm System and Gas Detection System. The battery shall be sized to operate the Single Station Gas Detectors at least 20 hours in standby mode and 5 minutes in the alarm mode.
 - c. 6 mill thick Visquene may be used in lieu of an Impervious Membrane, when the site is located in the Methane Zone with Site Design Levels I or II.
 - d. Additional Vent Risers or Mechanical Ventilation may be omitted for buildings with a width less than 50 feet or footprints less than 6,000 square feet in area.
 - e. Vent Risers provided at a rate twice shown in Table 2 on Sheet 4 maybe provided in lieu of Mechanical Extraction System.
6. Buildings Located in the First Phase Playa Vista Project. The First Phase Playa Vista project, as approved by the City on September 21, 1993 and December 8, 1995, shall comply with the methane mitigation program as required by the Department pursuant to the Methane Prevention, Detection and Monitoring Program approved by the Department on January 31, 2001, in lieu of the requirements of the Building Code, Division 71.

C. PAVED AREAS

The requirements for venting paved areas over 5,000 square feet in area and within 15 feet of the exterior wall of a commercial, industrial, institutional or residential building may be accomplished with either of the following:

1. If the site is located in the Methane Buffer Zone, then venting is not required for paved areas that qualify for Site Design Levels I, II, or III, or
2. Install vents in accordance with Detail 13 on Sheet 8, or
3. Install landscaping areas immediately adjacent to the building exterior walls at least two feet wide covering at least 80% of the building perimeter.

D. EXISTING BUILDINGS

Additions, alterations, repairs, change of use or change of occupancy to existing buildings shall comply with the methane mitigation requirements of the Building Code, Sections 7104.1 and 7104.2, when required by Division 34, 81, or 82 of the Building Code.

Approved methane mitigation systems in existing buildings shall be maintained in accordance with Building Code, Section 7106.

E. MAINTENANCE OF MITIGATION SYSTEMS

All gas detection and mechanical ventilation systems shall be maintained and serviced in proper working condition and meet all requirements of the Los Angeles Electrical and Mechanical Code. The testing, maintenance and service procedure for gas detection and mechanical ventilation systems shall be performed in accordance with the manufacturer's current written instructions and the following:

1. The manufacturer's instructions shall be approved by the Fire Department. A person certified by the Fire Department shall perform testing and servicing of each system.
2. A permanent notification placard shall be posted and maintained at the front entrance of the building indicating that the building is constructed with an Impervious Membrane, except in residential buildings. The placard shall indicate the presence of the Impervious Membrane. The location of the placard shall be such that it is legible from 10 feet away and when cast in floors shall remain uncovered and in a conspicuous location. The letters should be at least 1 inch high.

V. DESIGN CRITERIA

A. PASSIVE SYSTEM

1. De-Watering System

- a. De-Watering System is required when the Historical High Ground Water Table Elevation is within twelve (12) inches from the lowest Perforated Horizontal Piping.
- b. De-watering system is not required for either of the following: (1) if during the Site Testing, the groundwater level is deeper than 10 feet below the Perforated Horizontal Pipes, or (2) if the soil investigation or analysis, as approved by the Department, reveals the groundwater level is more than 12 inches below the bottom of the Perforated Horizontal Pipes.
- c. De-watering rates shall be noted on the methane mitigation plans. The engineer or geologist responsible for determining the dewatering rates shall approve the plans.
- d. Applications for water discharge location shall be approved and permitted by the Department of Public Works:
 - i. Bureau of Sanitation, Industrial Waste and
 - ii. Bureau of Engineering, Storm Water Management.
- e. The de-watering pipe shall be minimum Schedule 40, slotted or perforated Polyvinyl Chloride (PVC) pipe or other materials approved under LARR for the intended use.
- f. De-watering pipes shall be installed as follows:
 - i. De-watering pipes shall be sloped at 1/4 inch vertical to 12 inch horizontal (2% slope). The slope may be reduced to 1% if the pipe size is increased one full size in pipe diameter.
 - ii. Combination de-watering and Sub-Slab vent piping system may be used when installed with a minimum nominal 4 inch diameter pipes.
- g. Each sump pump pit shall contain a primary pump and a back-up pump.

2. Sub-Slab Vent System

Sub-Slab Vent System shall consist of Perforated Horizontal Pipes, Gravel Blanket Under Impervious Membrane, Gravel Around Perforated Horizontal Pipes and Vent Risers.

a. Perforated Horizontal Pipes:

- i. Perforated Horizontal Pipes shall be minimum Schedule 40, slotted or perforated PVC pipe or other materials approved by a LARR for the intended use.
- ii. Perforated Horizontal Pipe shall be installed as follows:
 - Spacing and location of Perforated Horizontal Pipes shall be per Table 2 on Sheet 4.
 - Pipes used only as vents may be installed in the horizontal position,
 - Combination vent/dewatering pipes shall be sloped at 1/4 inch vertical to 12 inch horizontal (2% slope) and
 - Undulations in the Perforated Horizontal Pipes, which may impede the passage of gas, shall be avoided (e.g. Perforated Horizontal Pipes shall not be deformed to pass below interior footings).

b. Gravel Blanket Thickness Under Impervious Membrane:

- i. The thickness of the Gravel Blanket under Impervious Membrane shall be per Table 1A and 1B shown on Sheet 4.
- ii. The composition of gravel shall be washed particles that have no more than one fractured face.
- iii. The gradations of gravel shall conform to Table 3 shown on Sheet 4.
- iv. The gradations of sand shall conform to Table 4 shown on Sheet 4.

c. Gravel Thickness Around Perforated Horizontal Pipes:

- i. Gravel thickness around Perforated Horizontal Pipes shall be per Table 1A and 1B shown on Sheet 4.
- ii. When sand is used as the Gravel Blanket a geo-fabric to prevent sand from entering the Perforated Horizontal Pipes shall be placed around the Perforated Horizontal Pipes.
- iii. Gravel shall be composed entirely of particles that have no more than one fractured face.

d. Vent Risers:

- i. Vent Risers shall be connected to Perforated Horizontal Pipes and constructed of cast iron. Exception:
 - Acrylonitrile Butadiene Styrene (ABS) pipes may be allowed for residential buildings up to two (2) stories, or
 - Any other material approved by a LARR for the intended use as methane Vent Riser.
- ii. Vent Risers shall be spaced and located as per Table 2 on Sheet 4.
- iii. Vent Riser outlets shall be located at least:
 - 10 feet above grade,
 - 10 feet away from any window, doors, roof hatch, opening or air intake into the building,
 - 3 feet above highest point of roof within a 10' radius of outlet,
 - 3 feet away from any parapet,
 - 4 feet away from the property line and
 - 5 feet away from any electrical device.
- iv. If rain guards are provided, they shall be non-restricting.

3. Impervious Membrane

a. Impervious Membrane Installation:

- i. Installation shall comply with the conditions of approval specified in a LARR and manufacturer's specification of the Impervious Membrane.
- ii. Impervious Membrane shall be installed at the following locations:
 - Below the building slab surrounded by the inner face of the exterior footings
 - On the exterior surface of walls from the finished grade level to a minimum of 6 inches below the bottom of the adjoining building slab
 - Around sides of pile caps and caisson capsException:
 - Impervious Membrane shall not be installed under exterior or interior footings.
- iii. Impervious Membranes at elevator and sump pits shall be installed as follows:
 - Two layers of Impervious Membrane below slabs and footings of all elevator pits, sump pits and holding tanks.
 - Impervious Membrane does not need to be placed below elevator pistons.
 - Impervious Membrane shall be attached to the elevator piston cylinder casing or at the sump pit floor slab to prevent methane intrusion.
- iv. The individual certified by the manufacturer of the Impervious Membrane shall certify on the Impervious Membrane Installation Certificate (see Sheet 3) that the Impervious Membrane was installed per approved plans.
- v. The completed Form 3 shall be given to the inspector prior to placement of parts or the whole concrete floor slab.

b. Seals at Impervious Membrane Penetrations:

- i. Where footings, plumbing pipes, electrical conduits and other materials penetrate the Impervious Membrane, the penetrations shall be sealed by using sleeves or boots composed of the same material or other approved materials and methods in accordance with the specifications of the manufacturer for the Impervious Membrane.

- ii. A gas tight seal shall be provided where the Impervious Membrane is attached to all interior footings and exterior wall footings.
- iii. All elevator piston shaft casing shall be constructed of a material allowed by the elevator code and sealed at the elevator pit floor slab level in accordance with the specifications of the Impervious Membrane manufacturer.
- iv. The bottom of the elevator piston casing shall be sealed to prevent gas migration into the building.

c. Impervious Membrane Protection Prior to Floor Slab Placement

- i. Installation Sequence for Protection Material Below the Impervious Membrane:
 - Finish the Gravel Blanket smooth using mechanical means (e.g. roller).
 - Place geotextile filter fabric over the Gravel Blanket to protect the smooth finish of the Gravel Blanket and prevent sand migration into the Gravel Blanket.
 - Prepare protective course for Impervious Membrane. Option A: If Sand is used as Gravel Blanket, then the Impervious Membrane may be placed directly on the geotextile, or Option B: If Gravel is used as for the Gravel Blanket, then place a minimum 1-inch thick Sand layer directly over the geotextile. Option C: If Gravel is used as for the Gravel Blanket, then place a geotextile with a minimum weight of 16 ounces per square yard.
- ii. Installation Sequence for Protection Material Above the Impervious Membrane:
 - Place 2-inch thick sand directly over the Impervious Membrane, or a minimum 1-inch thick lean concrete mix (slurry as specified in the Standard Specifications for Public Works Construction, Green Book)
 - Place geotextile fabric if sand is used in the prior step. If lean concrete mix is used, geotextile is not required.
 - Place concrete, reinforcing steel, piping and other forms so as not to be supported directly on the Impervious Membrane. Equipment shall not be driven over the Impervious Membrane or its protective covering.

B. ACTIVE SYSTEM

The Active System consists of the Sub-Slab System, Lowest Occupied Space System and Control Panel.

1. Sub-Slab System

Sub-Slab System shall consist of Pressure Sensors and a Mechanical Extraction System.

a. Pressure Sensors

- i. All devices and wiring shall be listed by a recognized testing laboratory and suitable for the intended use in the classified hazardous or corrosive environments.
- ii. Pressure Sensors shall receive power, report gas pressures and be calibrated by signals from the Gas Detection and Pressure Sensor Control Panel.
- iii. Probes for Pressure Sensors shall be installed within the Gravel Blanket a minimum of 2 inches below the Impervious Membrane.
- iv. A minimum of two Pressure Sensors shall be installed in buildings with footprint less than or equal to 20,000 square feet. For buildings with footprint more than 20,000 square feet, install Pressure Sensors at a rate of one per 20,000 square feet or portion thereof.
- v. Pressure sensor devices shall be located to accurately measure gas pressure below the Impervious Membrane relative to the ambient pressure of lowest occupied spaces.
- vi. Methane Vent Risers and Perforated Horizontal Pipes shall not be used to run wires to the Pressure Sensors.

b. Mechanical Extraction System

The Mechanical Extraction System shall consist of Detectors in Vent Risers, Gas Detection and Pressure Sensor Control Panel and Gas extraction powered devices and shall be designed in consideration for the migration of subsurface gas from adjacent properties.

i. Detectors in Vent Risers

- Detectors and associated transmitters shall be listed by a recognized testing laboratory for the intended use.
- Detectors and associated wiring shall be immune to radio frequency and infrared remote-transmitters frequency interference.
- Detector shall be fitted within the vent pipe so that no gas may leak through the fittings.
- The associated wiring and associated raceways shall be:
 - Mounted to a secure surface independent of detectors and their associated transmitter.
 - Protected from physical damage.

ii. Gas Extraction Powered Devices

- Gas extraction powered devices shall consist of fans, blowers, or other powered devices to exhaust or provide make-up air into the space below the Impervious Membrane and shall be capable of ventilating the Gravel Blanket and Perforated Horizontal Pipes spaces at a rate of 3 air changes per hour.
- The total volume Gravel Blanket used to size the Gas Extraction Powered Devices shall include the volume of air (pore space) in the Gravel Blanket.
- Unless porosity of the gravel blanket material is established by a test report prepared by a licensed engineer or registered geologist, porosity of the gravel blanket material may be taken as 25%.

SITE ADDRESS:

LEGAL DESCRIPTION:
OWNER:

STANDARD PLAN:
METHANE HAZARD MITIGATION
Not to be used for Playa Vista Projects

Rev.:
Date: 02/01/06
Scale: Not to Scale
Drawn:
Job:
Sheet:

2. Lowest Occupied Space System

The Lowest Occupied Space System shall consist of Gas Detection System, Mechanical Ventilation System and Alarm System.

a. Gas Detection System

- i. The specifications for Detectors shall be the same as specified for Detectors in Vent Risers except as modified in Table 5 - Activation Thresholds for Active System.
ii. Detectors in lowest occupied spaces shall be installed in accordance with manufacturers' requirements and listing agency approvals.
• Detectors shall be located with respect to airflow in rooms, location of probable gas leaks and the recommendations of the manufacturer.
• Number of required Detectors shall be based on Table 6 - Detector Spacing.

b. Mechanical Ventilation System

- i. Mechanical Ventilation System shall consist of blowers, fans or other powered devices for exhaust or make-up air as approved by Mechanical Plan Check Section.
ii. The make-up air shall be 100% outside air.
iii. Mechanical Ventilation System shall be provided using one of the following options for garage lowest occupied and unoccupied spaces:

Option #1: Activated Mechanical Ventilation - Mechanical Ventilation System shall be capable of removing methane gas at a rate of 4 air changes per hour when activated by the Gas Detection and Control Panel, at 10% LEL (5,000 ppmv). Back-up power is not needed for mechanical ventilation in this option. Parts of fans in this Option shall be of nonferrous or non-sparking materials or their casing shall be lined or constructed of such material.

Option #2: Continuous Ventilation - Mechanical Ventilation System sized to ventilate the building spaces at a rate of one (1) air change per hour on a continuous basis. Mechanical ventilation in this option shall be provided with 24 hours of back-up power when Detectors and Pressure Sensors are not provided.

Option #3: Scheduled Start-up Ventilation - Mechanical Ventilation System shall start-up at least once every (6) six hours to provide a minimum of 24 air changes per day. Mechanical ventilation in this option shall be provided with 24 hours of back-up power when Detectors and Pressure Sensors are not provided.

Option #4: Alternate Natural Ventilation - Alternate method of ventilation may be utilized in lieu of mechanical ventilation in Options #1, #2 and #3 when designed in accordance with the Natural Ventilation requirements of this Standard Plan.

c. Alarm Systems

- i. Alarm Systems shall consist of audible and visual signals to notify occupants of significant levels of methane intrusion into the building and shall be designed with the Sequence of Operation shown in Table 5 of this Standard Plan.
ii. Audible alarms shall be at least 15dB above ambient noise level in all areas subject to methane gas intrusion.
iii. Visual alarms shall be a minimum of 15-candela output and be located at each audible device.
iv. The audible signal warning building occupants of significant levels of methane gas shall be distinctively different from the fire alarm system.
v. Signs shall be posted adjacent to each alarm signaling device indicating, "Methane Alarm-Evacuate Building."

3. Control Panel

a. General Installation

- i. Control Panel shall be listed by a recognized testing laboratory.
ii. Control Panel shall have the following characteristics:
• Designed not to override the building fire alarm, smoke control and ventilation systems.
• A manual shall be provided with the Control Panel describing the installation, wiring, operation, maintenance and testing.

b. Power Source

- i. Primary Power Source
• Control Panel shall be hard wired to the building normal power.
• The circuits supplying power to the Control Panel shall be lockable in the open position.
ii. Back-Up Power Supply
• Control Panel shall monitor the power to Detectors and Pressure Sensors, annunciator and associated components.
• Back-Up battery or emergency power shall be rated for a minimum of 24 hours for standby mode plus 5 minutes of alarm under full load condition.
• This Back-Up power shall be available within 60 seconds of primary power loss.

c. Panel Operation

i. Device Activation

- Control Panel shall recognize alarm conditions, and then activate required audible devices, visual devices and Gas Extraction Powered Devices.
• Components of the Active System shall be activated as shown in the Table 5 on Sheet 4 - Activation Thresholds For Active Systems.

ii. Trouble Annunciation

- Control Panel or annunciator shall indicate each trouble or alarm condition by a visual alarm.
• Control Panel shall supervise and identify fault and trouble conditions with the following:
- Main supply circuits,
- Rechargeable battery circuits,
- Initiating device circuits,
- Alarm device circuits,
- Supplementary or auxiliary signaling circuits and,
- Signaling line circuits.

C. MISCELLANEOUS SYSTEMS

1. Trench Dam

Trench dams are intended to prevent travel of underground gas into buildings or structures along the trench backfill.

- a. A Trench Dam shall be installed in all electrical, plumbing, gas, or other trenches beneath the building foundation.
b. If piping and conduits are placed before certified compacted soil as part of the site preparation for the building pad, then trench dams will not be required.
c. Trench dams shall be installed in the trench immediately adjacent to the exterior perimeter of the building foundation.
d. A Trench Dam shall have a minimum length of twice the width of the trench or a minimum of 36 inches in length.
e. Trench dams may be of the following:
i. Bentonite Cement Slurry - A mixture of 4% Type II Cement, and 2% Powdered Bentonite, or
ii. Compacted Native Soil Backfill - Native soil shall be compacted to at least 90% relative compaction in accordance with ASTM D-1557 Testing Procedures.
f. The entire cross section of trenches shall be backfilled to provide a minimum of 6 inches of trench dam material around all conduits and pipes.

2. Hazardous Area Classification

For the purpose of determining the appropriate electrical wiring method and equipment, boundaries of the hazardous area classification are specified in Tables 7, 8 and 9. The Hazardous Area Classification, except as noted below, is based on the measured gas concentration and pressure as indicated in Site Investigation report:

- a. In the absence of pressure reading in a site investigation report, the area classification shall be based on soil gas pressure that is greater than 2 inches of water.
b. In the absence of a site investigation report, the area classification shall be based on Methane Design Level V.

3. Wiring

The wiring system shall be in accordance with the Los Angeles Electrical Code and as required herein.

a. Depressurization Enclosure

- i. Wiring system between a classified area and a non-classified area shall be supplemented by a Depressurization Enclosure when the Design Methane Pressure is greater than 6 in. of water.
• Depressurization enclosure is not required when each continuous underground wiring duct bank system supplied from an approved vented manhole is less than 500 linear ft. (152.4 m.) from a termination point and the total load does not exceed 80% of the rating of the conductors. Longer duct bank run may be permitted when justified by engineering analysis.
• Depressurization enclosure is not required when the maximum-recorded pressure does not exceed the rating of a listed and approved seal fitting.
ii. The wiring system supplied from the Depressurization Enclosure shall be installed above ground.
iii. The Depressurization Enclosure shall be suitable for the location and shall contain only electrical wiring. The depressurizing enclosure shall be located outdoors and shall comply with one of the following options:
• A standard pull box fitted with a breather suitable for Class I, Group D locations where:
- The breather shall be located on the side of the enclosure within 2 inches from the top of the pull box.
- The breather shall have minimum dimensions of 1.5 inches long and 15/16 inch diameter; or
• A standard pull box fitted with louvered ventilation where:
- The louvered openings shall be within 2 inches from the top of the box.
- The minimum total enclosure ventilation opening shall be 1.41 square inches. A louvered pull box shall be installed in a non-classified area.

- b. Outdoor Enclosures
All outdoor enclosures with open bottoms, when installed on grade or finished floors, shall be mounted on a minimum 2-in. (5.08 cm.) thick concrete pad over a 30 mil (0.076 cm.) High Density Polyethylene (HDPE) or equivalent approved impervious membrane. All membrane penetrations shall be suitably sealed against transmission of gas into the enclosure.
c. Conduit Seal Fittings and Cable Seal Fittings
Conduit Seal Fittings and Cable Seal Fittings are designed to prevent the passage of gases, vapors, or flames inside the electrical conduits.
i. Conduit or Cable Seal Fittings are required where conduits or cables pass through a classified hazardous area per the Los Angeles Electrical Code and as required in this Standard Plan.
ii. Any conduit or cable that penetrates the Impervious Membrane shall be provided with a conduit or cable seal.

- iii. Conduit Seal Fittings shall be installed in the vertical portion of conduit where the PVC conduit emerges from a classified location. Rigid material shall be rigid metal that has the same trade size as conduit runs.

d. Grounding Electrical Systems

Electrical systems required by the Los Angeles Electrical Code to be grounded shall be connected to earth using the prescriptive or performance (Soil Resistance) method.

i. Prescriptive Method

When a Ground Ring is not used as part of the Grounding Electrical Systems required by the Los Angeles Electrical Code at least one of the following supplemental grounding electrodes shall be used:

- Rod and Pipe Electrodes
• Plate Electrodes

The supplemental grounding electrode conductor shall not be reduced in size.

ii. Soil Resistance Method

Grounding systems other than specified in the Prescriptive Method shall be based on Soil Electrical Resistivity Test as follows:

- Soil Electrical Resistance
- The soil resistivity shall be measured by the four-point method as described in IEEE Standard 81-1983.
- The measurement of soil resistance shall take into account the geological features of the soil as determined by the engineer.
- Whenever driven ground rods are to be used, the soil resistivity measurement shall correlate with the installed effective depth of the ground electrodes.
- The engineering analysis of the data shall take into account the expected soil temperature, moisture and gas or soluble chemical contents.
- The engineering analysis shall reflect the uniformity of soil resistivity using not less than ten readings based on the test pin electrode spacing.
- The soil resistivity measurement shall be based on embedment of the electrodes below the permanent moisture level, when such installation is possible.
• Measurement
- For installations of multiple rod and pipe or plate electrodes in a single row, measurement shall be in a straight line at the location where these electrode(s) are intended to be installed.
- For installations of ground ring (circular or square), grids, grid beds, radial, etc, the area that is to be used for grounding shall be divided into rows. Each row shall be equally spaced apart. The measurement shall be started at the corner of the first row and then continued through each pre-determined point in the row. This measurement is then repeated through the last row. The measurement shall be performed until all pre-determined points are covered.
- These measurements shall account for water table, soil layers, corrosion, etc. when applicable.
• Soil Electrical Resistance Design:
- For multiple rod and pipe or plate electrodes installed in a straight line, the measured current and voltage shall be used to calculate the average soil resistivity.
- For an area, the measured current and voltage shall be used to calculate the average soil resistivity for each row. The highest calculated average soil resistivity of any row shall be used to calculate the soil resistivity.
- In the event the soil in the area or location under consideration is found to be non-uniform, the soil shall be modified and the test(s) shall be repeated. Ground Resistance (Impedance) Limitation - The overall ground resistance (Impedance) of a grounding electrode system shall not exceed 25 ohms for 600 volts or less low voltage systems and not to exceed 5 ohms for over 600 volts high voltage systems.

4. Manholes and Other Underground Electric Enclosures Intended for Personnel Entry

The provisions of this section are applicable to all manholes and other underground electric enclosures that are intended for personnel entry. These enclosures herewith will be referred to as underground electrical enclosures.

a. Vent System

- i. Underground electrical enclosures shall be naturally ventilated at all time to open air in an approved manner to prevent the build-up of methane.
ii. Mechanical ventilation in lieu may be used when back-up power sufficient to run the system for 24 hours is provided and a visual and audible main power failure alarm at a readily accessible location.

b. Enclosure Exterior

- i. Approved seals shall be used to prevent water and methane gas from entering the sides of the underground electrical enclosures.
ii. Underground electrical enclosures personnel entry access cover shall be provided with an approved restraining system.
iii. Soil gases under the underground electrical enclosures shall be vented in a manner shown in the Standard Plan Details.

c. Enclosure Interior

- i. All wiring terminations, equipment and insulating materials within the enclosure shall be suitable for wet location.

- ii. Approved duct seals shall be used to prevent water from the conduits entering or leaving the manholes and other underground electrical enclosures intended for personnel entry. The seal shall have a depth of not less than the diameter of the conduit.

5. Additional Vent Risers

The total quantity of installed Vent Risers shall be increased to double the rate for the Passive System.

VI. SYSTEMS MAINTENANCE

A. PROCEDURES

The test, maintenance and service procedure for Gas Detection System and Mechanical Ventilation System shall be performed in accordance with the manufacturer's instructions. These instructions shall be approved and filed with the LAFD. A person approved by the LAFD, shall perform testing and servicing of the Gas Detection System and Mechanical Ventilation System.

B. SCHEDULE

Notwithstanding the recommendations of the manufacturer, testing, maintaining and servicing of each system shall be performed at least once annually.

C. REPAIRS

All components required to mitigate methane hazards shall be repaired or replaced to the manufacturer's original specification.

D. OCCUPANT NOTIFICATION

A permanent notification shall be provided at each building indicating the presence of the methane Impervious Membrane. This notification shall be at the front entrance, be visible and be legible as approved by the Engineer and LADBS. See Detail 14 on Sheet 8.

VII. EMERGENCY PLAN

An emergency plan outlining emergency procedures shall be established for all buildings with a gas-detection system, with the exception of buildings with R3 or U Occupancies. The procedures shall include, but not limited to, the identification of the responsible person assigned to manage the contingency plan, posting of the contingency plan and the approval process of the contingency plan.

A. RESPONSIBLE PERSON

The assigned responsible person shall work with the Fire Department in the establishment, implementation and maintenance of an emergency plan.

B. POSTING

A sign shall be posted in a conspicuous location designated by the Fire Department with the Fire Department's telephone number.

C. APPROVAL

All contingency plans for emergency procedures shall be approved by the Fire Department.

SITE ADDRESS:
LEGAL DESCRIPTION:
OWNER:

STANDARD PLAN:
METHANE HAZARD MITIGATION
Not to be used for Playa Vista Projects

Table with 2 columns: Field Name, Value. Fields include Rev., Date (02/01/06), Scale (Not to Scale), Drawn, Job, Sheet.

Table 1A - MITIGATION REQUIREMENTS FOR METHANE ZONE (See note 1)

| Site Design Level | Level I | Level II | Level III | Level IV | Level V | | | | | |
|--------------------------------------------------|-------------------------------------|----------------------------------------------------------|---------------|----------------|--------------|----|----|----|----|----|
| Design Methane Concentration (ppmv) | 0 - 100 | 101 - 1,000 | 1,001 - 5,000 | 5,001 - 12,500 | > 12,500 | | | | | |
| Design Methane Pressure (inches of water column) | ≤ 2" | > 2" | ≤ 2" | > 2" | All Pressure | | | | | |
| PASSIVE SYSTEM | De-watering System | | X | X | X | X | X | X | X | |
| | Sub-Slab Vent System | Perforated Horizontal Pipes | X | X | X | X | X | X | X | |
| | | Gravel Blanket Thickness Under Impervious Membrane | 2" | 2" | 2" | 3" | 2" | 3" | 2" | 4" |
| | | Gravel Thickness Surrounding Perforated Horizontal Pipes | 2" | 2" | 2" | 3" | 2" | 3" | 2" | 4" |
| | | Vent Risers | X | X | X | X | X | X | X | X |
| Impervious Membrane | X | X | X | X | X | X | X | X | | |
| ACTIVE SYSTEM | Sub-Slab Vent System | | | | | | | X | X | |
| | Mechanical Extraction System | | | | | | | X | X | |
| | Gas Detection System | | X | | X | X | X | X | X | |
| | Mechanical Ventilation | | X | | X | X | X | X | X | |
| | Alarm System | | X | | X | X | X | X | X | |
| Control Panel | | X | | X | X | X | X | X | | |
| MISC. SYSTEM | Trench Dam | | X | X | X | X | X | X | X | |
| | Conduit or Cable Seal Fitting | | X | X | X | X | X | X | X | |
| | Additional Vent Risers (See note 4) | | | | | | | | X | |

Table 1B - MITIGATION REQUIREMENTS FOR METHANE BUFFER ZONE (See note 1)

| Site Design Level | Level I | Level II | Level III | Level IV | Level V | | | | |
|--------------------------------------------------|-------------------------------------|----------------------------------------------------------|---------------|----------------|--------------|----|----|----|----|
| Design Methane Concentration (ppmv) | 0 - 100 | 101 - 1,000 | 1,001 - 5,000 | 5,001 - 12,500 | > 12,500 | | | | |
| Design Methane Pressure (inches of water column) | ≤ 2" | > 2" | ≤ 2" | > 2" | All Pressure | | | | |
| PASSIVE SYSTEM | De-watering System (See note 1) | | | X | X | X | X | X | X |
| | Sub-Slab Vent System | Perforated Horizontal Pipes | | X | X | X | X | X | X |
| | | Gravel Blanket Thickness Under Impervious Membrane | 2" | | 3" | 3" | 2" | 4" | 4" |
| | | Gravel Thickness Surrounding Perforated Horizontal Pipes | 2" | | 3" | 3" | 2" | 4" | 4" |
| | | Vent Risers | X | | X | X | X | X | X |
| Impervious Membrane | | X | X | X | X | X | X | | |
| ACTIVE SYSTEM | Sub-Slab Vent System | | | | | | | X | X |
| | Mechanical Extraction System | | | | | | | X | X |
| | Gas Detection System | | X | | X | X | X | X | X |
| | Mechanical Ventilation | | X | | X | X | X | X | X |
| | Alarm System | | X | | X | X | X | X | X |
| Control Panel | | X | | X | X | X | X | X | |
| MISC. SYSTEM | Trench Dam | | X | | X | X | X | X | X |
| | Conduit or Cable Seal Fitting | | X | | X | X | X | X | X |
| | Additional Vent Risers (See note 4) | | | | | | | | X |

NOTES FOR TABLES 1A AND 1B:

- Components required for this project are identified by an "X" in the column circled.
- Table 1A - Mitigation Requirements for Methane Zone and Table 1B - Mitigation Requirements for Methane Buffer Zone are based on Table 71 and Chapter 71 of the Los Angeles Building Code.
- De-watering not required when the maximum Historical High Ground Water Table Elevation, or projected post-construction ground water level, is more than 12 inches below the bottom of the Perforated Horizontal Pipes.
- The total quantity of installed Vent Risers shall be increased to double the rate for the Passive System.

Table 2 - SPACING OF PERFORATED HORIZONTAL PIPES AND NUMBER OF VENT RISERS

| VENT RISER PIPE DIAMETER (inches) | MAX. SUB-SLAB PERFORATED HORIZONTAL PIPE SPACING (feet) | MAX. SUB-SLAB COMBINATION PERFORATED HORIZONTAL PIPE FOR DEWATERING AND VENT SPACING (feet) | NUMBER OF VENT RISER PER BUILDING FOOTPRINT AREA (square feet) |
|-----------------------------------|---------------------------------------------------------|---------------------------------------------------------------------------------------------|----------------------------------------------------------------|
| 1 1/2 | 12.5 | Not allowed | 1/1,250 (min of 2 risers) |
| 2 | 25 | Not allowed | 1/2,500 (min of 2 risers) |
| 2 1/2 | 50 | Not allowed | 1/5,000 (min of 3 risers) |
| 3 | 75 | Not allowed | 1/7,500 (min of 4 risers) |
| 4 | 100 | 50 | 1/10,000 (min of 4 risers) |

NOTE:

- Riser length shall be a maximum of 100' measured along pipe (including bends).
- Vent Risers max spacing shall be 100' measured along horizontal pipes.
- When the application of the spacing and location requirement of this table results in the requirement of a fractional number of Vent Risers, any fraction shall be construed as one Vent Riser.
- Horizontal pipes shall always be equal or larger in diameter than the vertical risers.
- Building Footprint shall be defined as the area in square feet contained within the exterior walls at or below the grade level.
- Vent Risers shall be located as per the above table for buildings with footprint areas covering up to 100,000 square feet.
- Vent Risers in buildings with footprint area covering over 100,000 square feet may use the minimum standards in the above table or an alternate method justified by engineering calculations approved by the LADBS.

Table 5 - ACTIVATION THRESHOLDS FOR ACTIVE SYSTEM

| System Name | System Component | SYSTEM COMPONENT TRIGGERED BY PRESSURE SENSORS, DETECTORS AND GAS SENSORS | | |
|----------------------------------|-----------------------------|---------------------------------------------------------------------------|---------------------------------------|---------------------------|
| | | Pressure Sensor Below Impervious Membrane | Detector in the Lowest Occupied Space | Gas Sensor in Vent Risers |
| Below Impervious Membrane System | Warning Annunciator | X | | |
| | Mechanical Extraction Fan | | | X |
| Lowest Occupied Space System | Mechanical Ventilation | | X | X |
| | Alarm (audible and visible) | | | X |
| | Warning Annunciator | X | X | X |

NOTE:

- Gas Detection Control Panels as part of the Lowest Occupied Space Systems and Below Impervious Membrane Systems, shall determine the gas concentration using a time weighted average of 10 minutes.

Table 6 - DETECTOR SPACING

| ROOM FLOOR AREA OR CONCEALED SPACE AREA (square feet) | NUMBER OF DETECTORS * | |
|-------------------------------------------------------|-------------------------------------------------------------------------------------------|----------------------------------------------------------------------|
| | WITH HEATING, VENTILATION AND AIR CONDITIONING | WITHOUT HEATING, VENTILATION AND AIR CONDITIONING |
| 10,000 and More | Minimum of 3 Detectors plus one for every 20,000 and fraction thereof in excess of 10,000 | Minimum of 6 Detectors plus one for every 2,500 and fraction thereof |
| More Than 5,000 and Less Than 10,000 | 3 Detectors | Minimum of 2 Detectors plus one for every 2,500 and fraction thereof |
| More Than 1,000 and Up to 5,000 | 2 Detectors | Minimum of 1 Detector plus one for every 2,500 and fraction thereof |
| 0 and Up to 1,000 | 1 Detector | 1 Detector |

NOTE:

- In addition to the required number of Detectors in this table, there shall be at least one Detector in each elevator shaft and enclosed stairway.

Table 3 - SPECIFICATIONS FOR GRAVEL

| SIEVE SIZE | PERCENTAGE PASSING SIEVE | |
|-------------------------|--------------------------|-------------|
| | 3/4" Gravel | 3/8" Gravel |
| 1-1/2" (37.5 mm) | 100 | - |
| 1" (25.0 mm) | 90-100 | - |
| 3/4" (19.0 mm) | 55-85 | 100 |
| 3/8" (9.5 mm) | 8-20 | 85-100 |
| No. 4 (4.75 mm) | 0-5 | 0-30 |
| No. 8 (2.36 mm) | 0-5 | 0-10 |
| No. 200 (75um) | 0-2 | 0-2 |
| ASTM C 131 TEST GRADING | B | C |

Table 4 - SPECIFICATIONS FOR SAND

| SIEVE SIZE | PERCENTAGE PASSING SIEVE |
|------------------|--------------------------|
| 3/8" (9.5 mm) | 100 |
| No. 4 (4.75 mm) | 90-100 |
| No. 8 (2.36 mm) | 75-90 |
| No. 16 (1.18 mm) | 55-75 |
| No. 30 (600 um) | 30-50 |
| No. 50 (300 um) | 10-25 |
| No. 100 (150 um) | 2-10 |
| No. 200 (75 um) | 0-5 |

SITE ADDRESS:
LEGAL DESCRIPTION:
OWNER:

STANDARD PLAN:
METHANE HAZARD MITIGATION
Not to be used for Playa Vista Projects

Rev.:
Date: 02/01/06
Scale: Not to Scale
Drawn:
Job:
Sheet:

Table 7 - OUTDOOR HAZARDOUS AREA CLASSIFICATION *

| LOCATION | PAVEMENT SIZE | METHANE DESIGN LEVEL | MEASURED SOIL GAS CONCENTRATION (ppmv) | MEASURED SOIL GAS PRESSURE (inches of water) | HAZARDOUS AREA CLASSIFICATION |
|---------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|----------------------|----------------------------------------|----------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| Below finished grade | None | I, II, III or IV | Less than 12,500 | Less than 2 | Unclassified |
| | | I, II, III or IV | Less than 12,500 | Greater than 2 | 5' or less depth; Unclassified 5' to 10' depth; Class I, Division 2 Over 10' depth; Class I, Division 1 |
| | | V | Greater than 12,500 | N/A | Over 10' depth; Class I, Division 1 |
| Below finished grade with pavement greater than 15' from the outside wall of a building or structure * | Less than 5,000 sq. ft. or Greater than 5,000 sq. ft. & Less than 25' in width | I, II, III or IV | Less than 12,500 | Less than 2 | Unclassified |
| | | I, II, III or IV | Less than 12,500 | Greater than 2 | 5' or less depth; Unclassified 5' to 10' depth; Class I, Division 2 Over 10' depth; Class I, Division 1 |
| | | V | Greater than 12,500 | N/A | Over 10' depth; Class I, Division 1 |
| Below finished grade with pavement greater than 15' from the outside wall of a building or structure * | Greater than 5,000 sq. ft. | I, II or III | Less than 5,000 | Less than 2 | Unclassified |
| | | IV | Less than 12,500 but more than 5,000 | Less than 2 | 2.5' or less depth; Unclassified 2.5' to 10' depth; Class I, Division 2 Over 10' depth; Class I, Division 1 |
| | | I, II, III or IV | Less than 12,500 | Greater than 2 | 10' or less depth; Class I, Division 2 Over 10' depth; Class I, Division 1 |
| | | V | Greater than 12,500 | N/A | Over 10' depth; Class I, Division 1 |
| Below finished grade with pavement less than or equal to 15' from the outside wall of a building or structure | Greater than 5,000 sq. ft. | I, II or III | Less than 5,000 | Less than 2 | 2.5' or less depth; Unclassified 2.5' to 10' depth; Class I, Division 2 Over 10' depth; Class I, Division 1 |
| | | IV | Less than 12,500 but more than 5,000 | Less than 2 | 10' or less depth; Class I, Division 2 Over 10' depth; Class I, Division 1 |
| | | I, II, III or IV | Less than 12,500 | Greater than 2 | 5' or less depth; Unclassified 5' to 10' depth; Class I, Division 2 Over 10' depth; Class I, Division 1 |
| | Less than 5,000 sq. ft. | V | Greater than 12,500 | N/A | Over 10' depth; Class I, Division 1 |
| | | I, II, III or IV | Less than 12,500 | Less than 2 | Unclassified |
| | | I, II, III or IV | Less than 12,500 | Greater than 2 | 5' or less depth; Unclassified 5' to 10' depth; Class I, Division 2 Over 10' depth; Class I, Division 1 |
| Sump Totally Submerged Partially Submerged Dry | N/A | N/A | N/A | N/A | Unclassified Class I, Division 2 Class I, Division 1 |
| | | N/A | N/A | N/A | Unclassified |
| Above Grade | Regardless | N/A | N/A | N/A | Unclassified |

NOTE:
* Unpaved open areas, such as planters or landscaping not less than 3' x 3' spaced at less than or equal to 50' from each others edge, the area in between them shall be treated as an area that is less than 5,000 sq. ft.. If the space in between them exceeds 50', that area can be construed as less than 5,000 sq. ft. provided that the conduit or cable is installed in a trench and back filled with 3/4-inch aggregate or gravel up to the grade.

Table 8 - VENT RISER HAZARDOUS AREA CLASSIFICATION

| LOCATION | POWER VENTILATED | HEMISPHERICAL DISTANCE FROM THE RIM OF THE VENT, A JOINT OR A FITTING | HAZARDOUS AREA CLASSIFICATION |
|-------------------------------------------------------------------------------------------------------------------------|------------------|-----------------------------------------------------------------------|-------------------------------|
| Vent Outlet | No | Within 0 to 3 feet | Class I, Division 1 |
| | | Within 3 feet to 5 feet | Class I, Division 2 |
| | | Over 5 feet | Unclassified |
| Vent Outlet | Yes | Within 0 to 5 feet | Class I, Division 1 |
| | | Within 5 feet to 10 feet | Class I, Division 2 |
| | | Over 10 feet | Unclassified |
| Joints and fittings not enclosed within wall spaces* | N/A | Within 0 to 3 feet | Class I, Division 2 |
| | | Over 3 feet | Unclassified |
| Joints and fittings in framed walls* | N/A | Any distance within the frame stud bay | Class I, Division 1 |
| In the Vent System | N/A | N/A | Class I, Division 1 |
| Gas Sampling Port | N/A | Within 0 to 3 feet | Class I, Division 2 |
| Mechanical extraction vent with direct drive blade motor with a mechanical check valve in the outlet of the motor duct. | Yes | N/A | Unclassified |
| Mechanical extraction vent with direct drive blade motor without a check valve in the outlet of the motor duct. | Yes | Within 0 to 3 feet | Class I, Division 2 |

NOTE:
* The hazardous area designation for these areas is considered as unclassified under any one of the following conditions:
a. All joints and fittings are welded in approved manner,
b. Approved double walled vent risers are provided, or
c. Approved four inch or smaller threaded steel pipe venting system or equivalent approved piping system is installed.

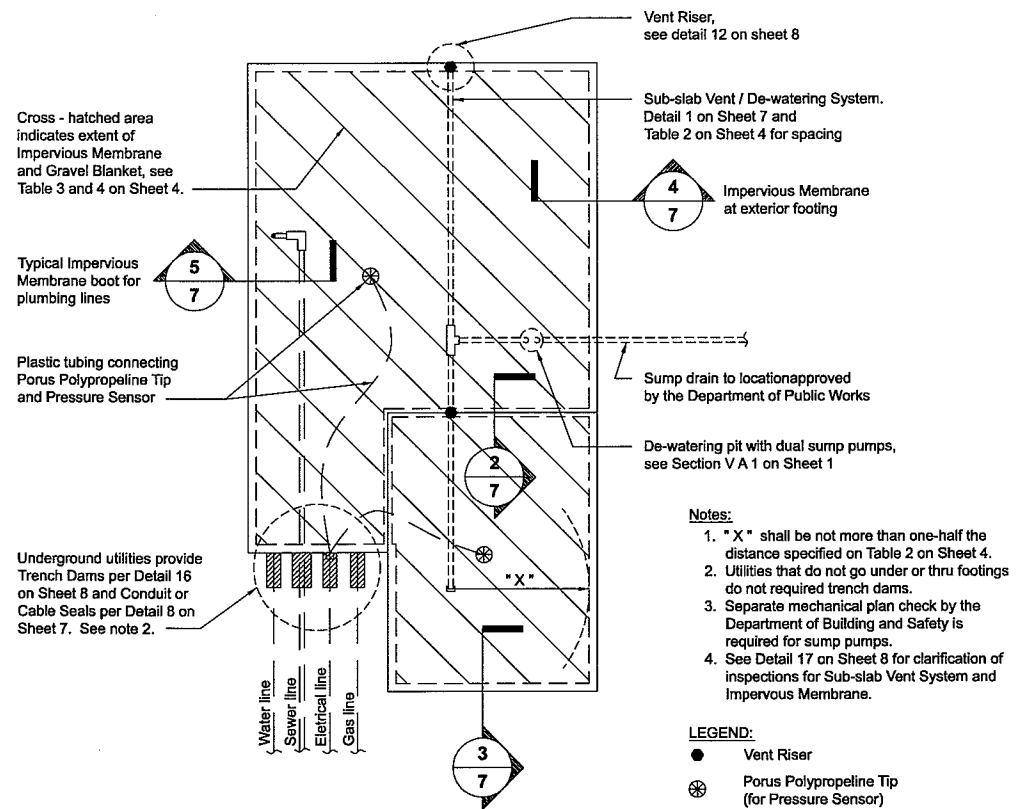
Table 9 - BUILDING HAZARDOUS AREA CLASSIFICATION

| LOCATION | METHANE DESIGN LEVEL | MEASURED SOIL GAS CONCENTRATION (ppmv) | MEASURED SOIL GAS PRESSURE (inches of water) | HAZARDOUS AREA CLASSIFICATION |
|---------------------------------------------------------------------------------------------------------------------------------------|----------------------|-----------------------------------------------|----------------------------------------------|-------------------------------------------------------------------------------|
| Below Impervious Membrane | I or II | Less than 1,000 | Less than 2 | Unclassified |
| | III or IV | Less than 12,500 but more than 1,000 | Less than 2 | 10' or less depth; Class I, Division 2 Over 10' depth; Class I, Division 1 |
| | I, II, III or IV | Less than 12,500 | Greater than 2 | Class I, Division 1 |
| | V | Greater than 12,500 | N/A | Class I, Division 1 |
| Below grade within the raised floor foundation or lowest building slab without an Impervious Membrane | I, II, III or IV | Less than 12,500 | Less than 2 | 10' or less depth; Class I, Division 2 Over 10' depth; Class I, Division 1 |
| | I, II, III or IV | Less than 12,500 | Greater than 2 | Class I, Division 1 |
| | V | Greater than 12,500 | N/A | Class I, Division 1 |
| Above grade within the raised floor foundation footing without an Impervious Membrane but with adequate ventilation per Standard Plan | I, II, III or IV | Less than 12,500 | Less than 2 | Unclassified |
| | I, II, III or IV | Less than 12,500 | Greater than 2 | Class I, Division 2 |
| Above Impervious Membrane, but below the lowest building slab or raised floor foundation | I, II, III or IV | Below Impervious Membrane Less than 12,500 | Below Impervious Membrane Greater than 2 | Unclassified |
| | I, II, III or IV | Below Impervious Membrane Less than 12,500 | Below Impervious Membrane Less than 2 | Unclassified |
| | V | Below Impervious Membrane Greater than 12,500 | N/A | Class I, Division 2 |
| Above Impervious Membrane, through the lowest building slab or Above slab | N/A | N/A | N/A | Unclassified |
| Sump Totally Submerged Partially Submerged Dry | N/A | N/A | N/A | Unclassified |
| | | | | Class I, Division 2 |
| | | | | Class I, Division 1 |

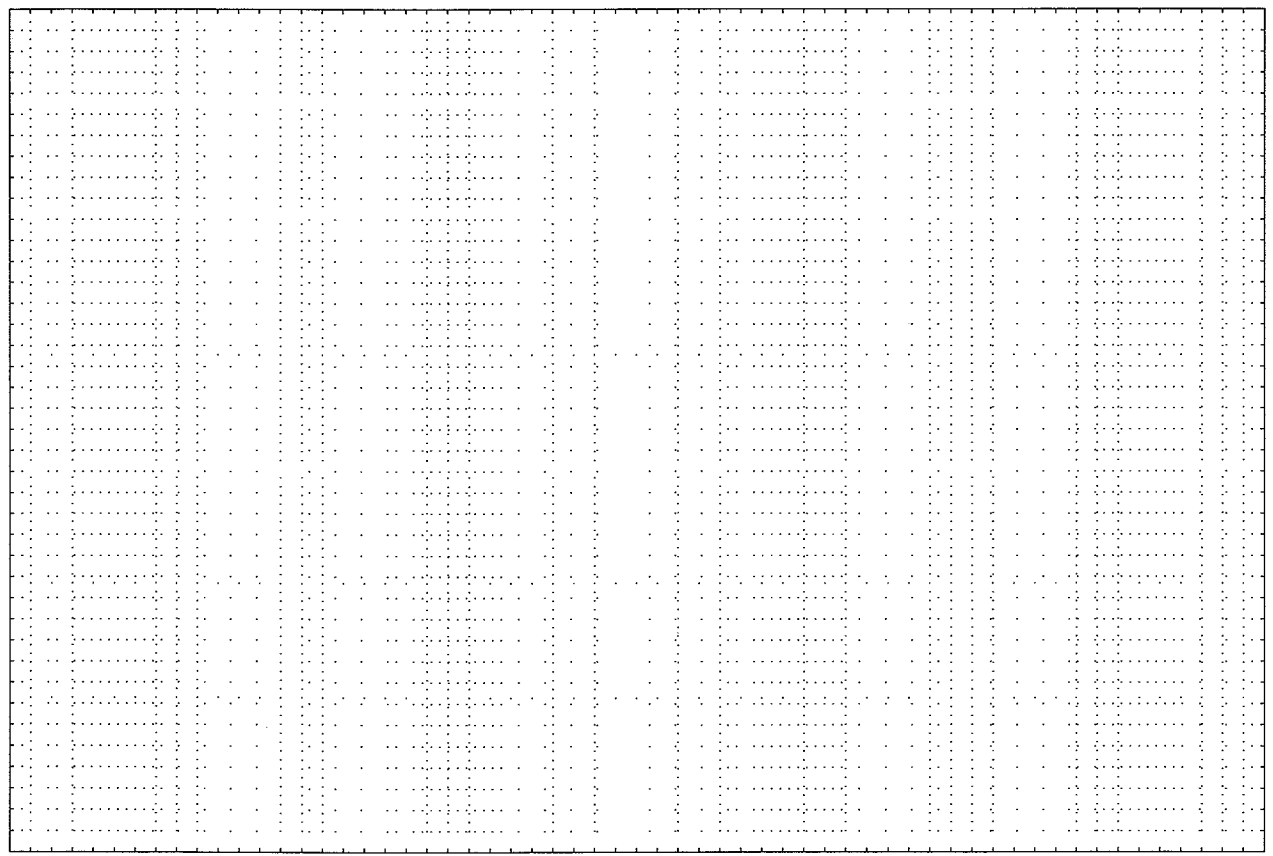
SITE ADDRESS:
LEGAL DESCRIPTION:
OWNER:

STANDARD PLAN:
METHANE HAZARD MITIGATION
Not to be used for Playa Vista Projects

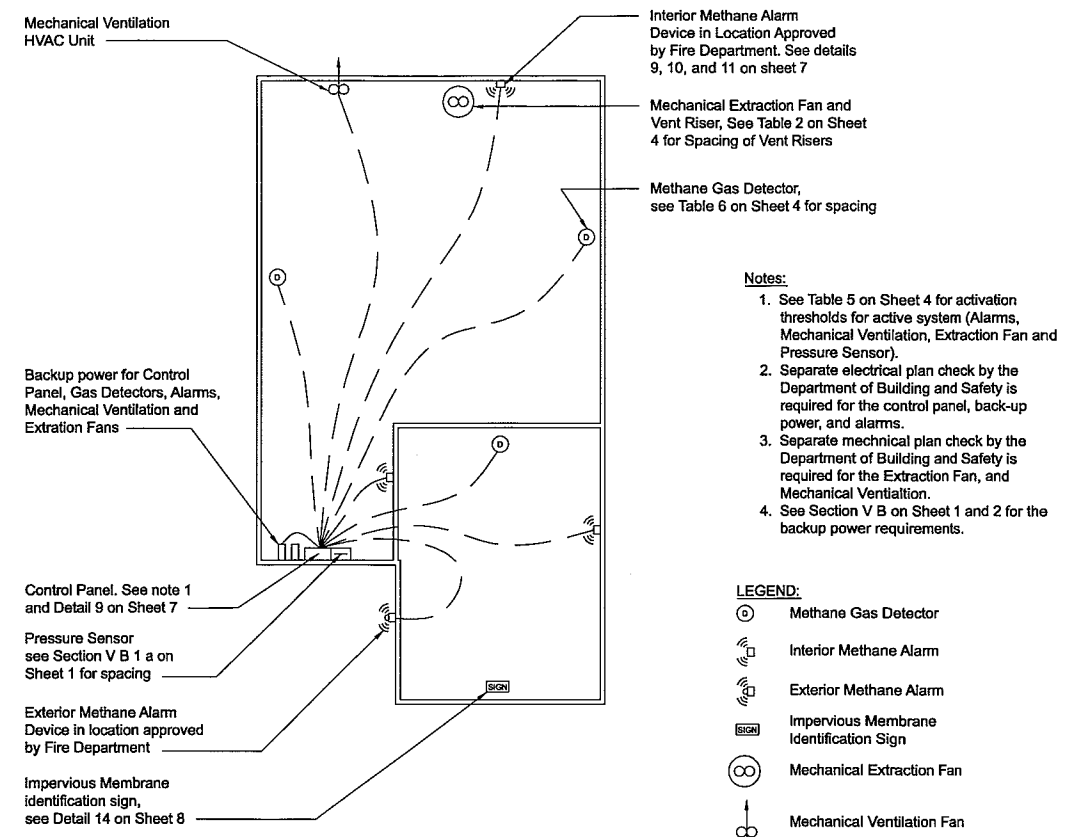
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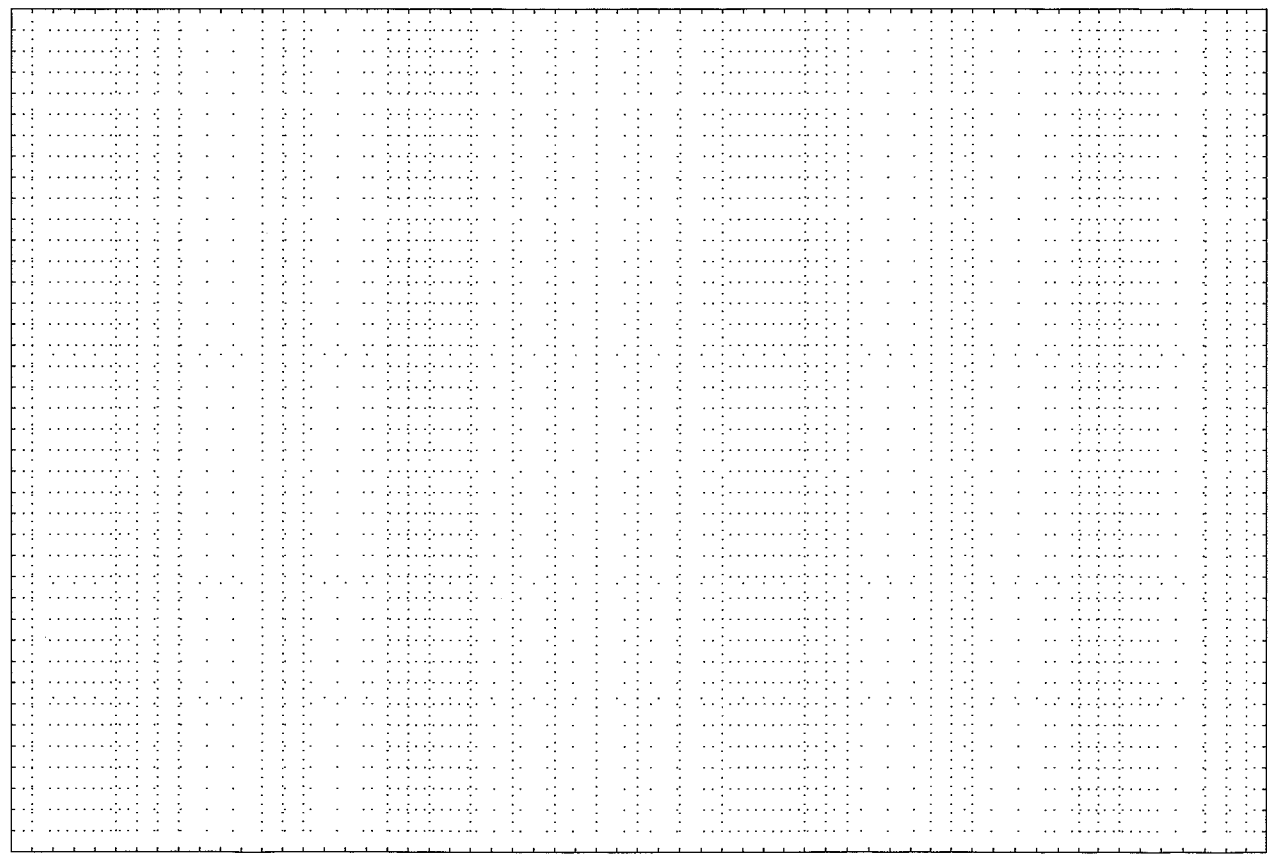
Sample Plan For Below Slab Methane Mitigation Components



Below Slab Methane Mitigation Components



Sample Plan For Above Slab Methane Mitigation Components

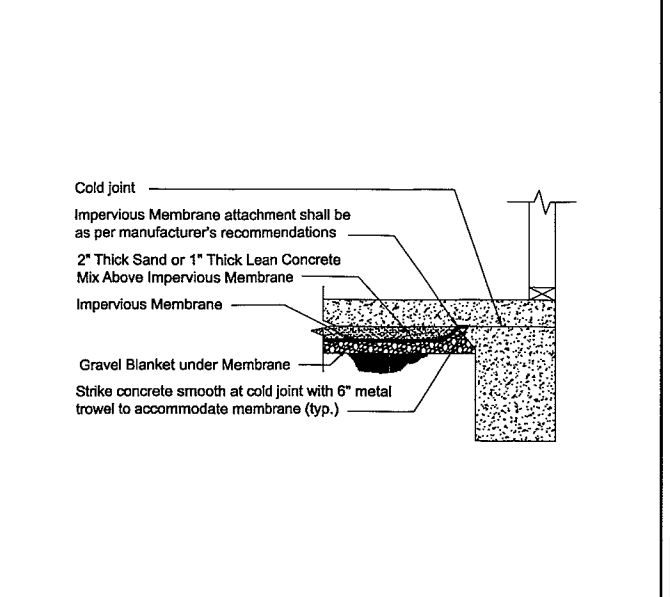
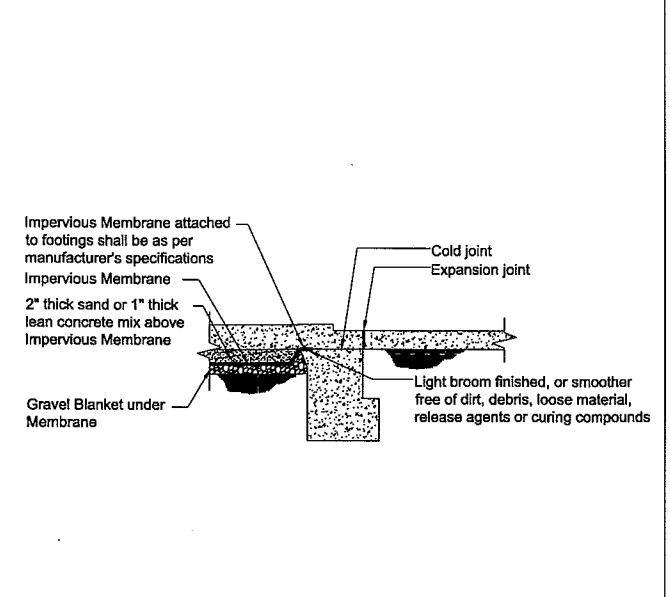
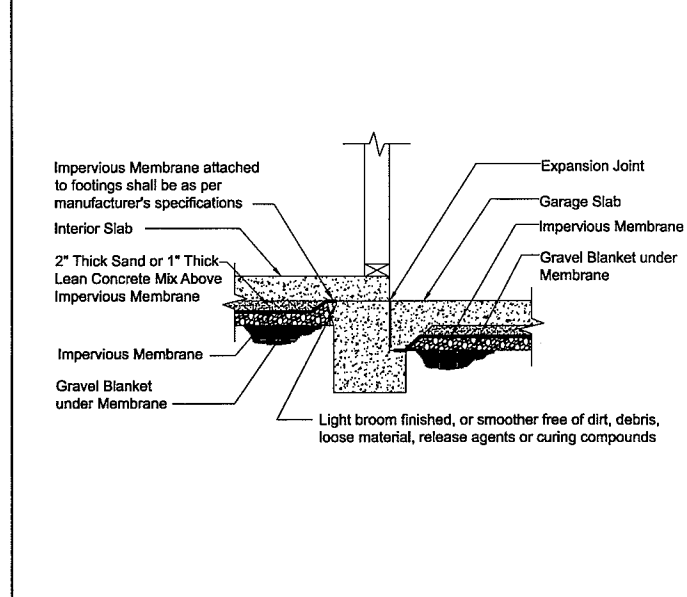
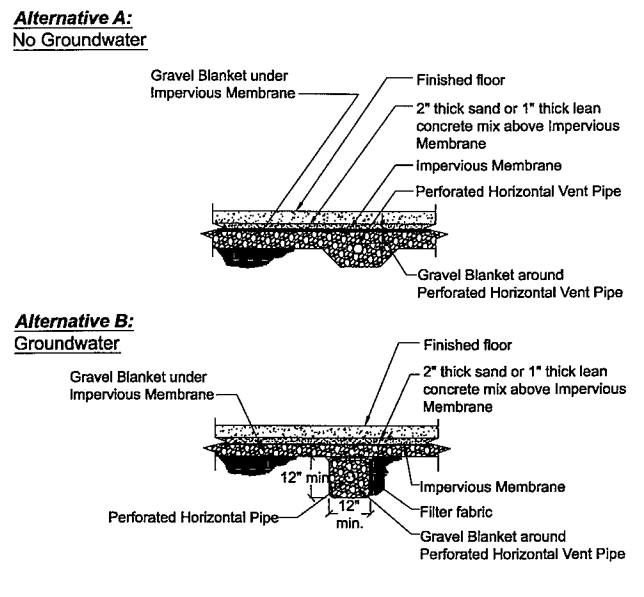


Above Slab Methane Mitigation Components

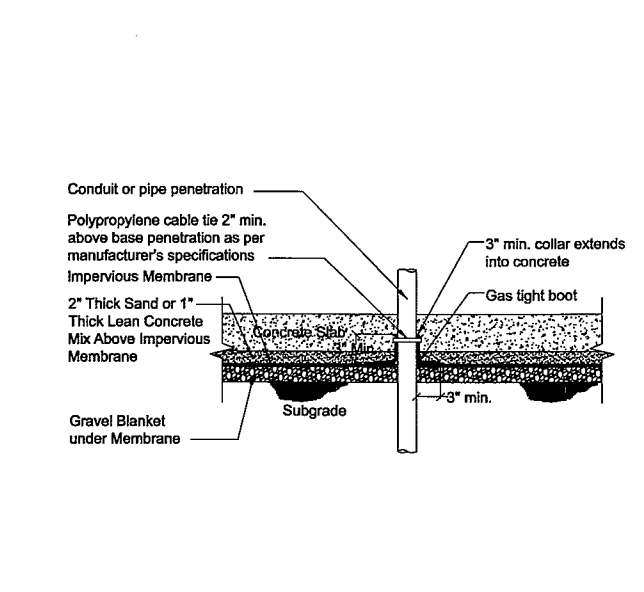
SITE ADDRESS:
LEGAL DESCRIPTION:
OWNER:

STANDARD PLAN:
METHANE HAZARD MITIGATION
Not to be used for Playa Vista Projects

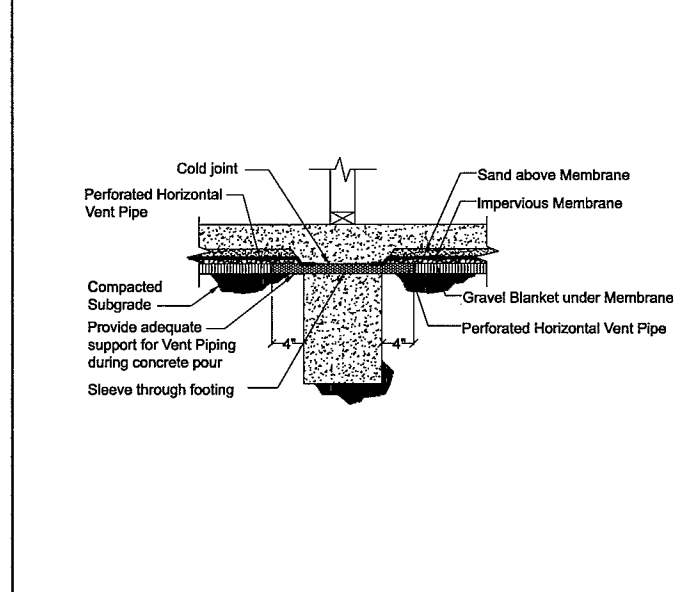
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Date: 02/01/06
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Job:
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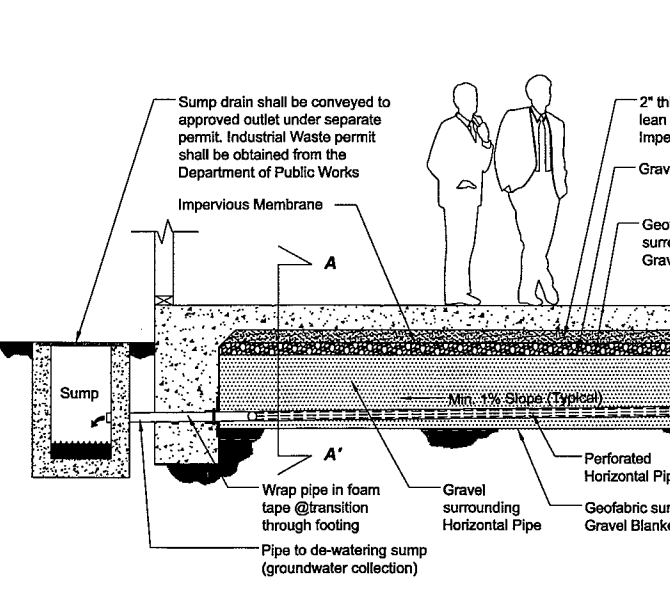
Sub-Slab Vent System **Detail 1**
Scale: Not to Scale



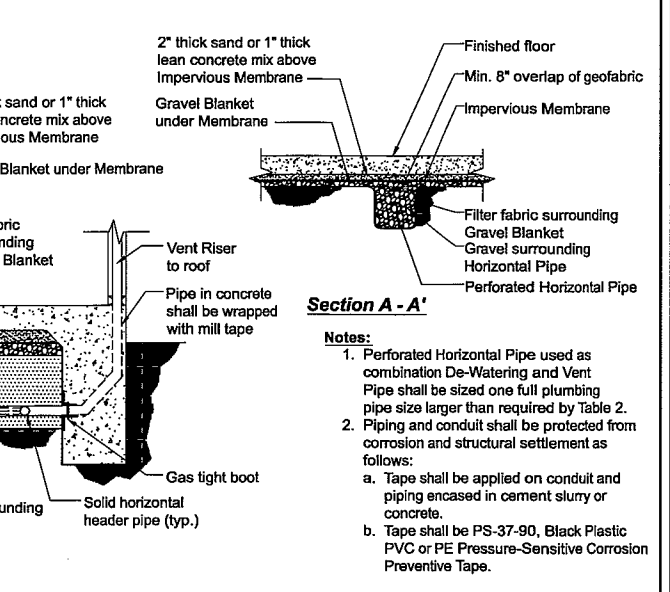
Membrane Termination at Garage/Dwelling Floor Transition **Detail 2**
Scale: Not to Scale



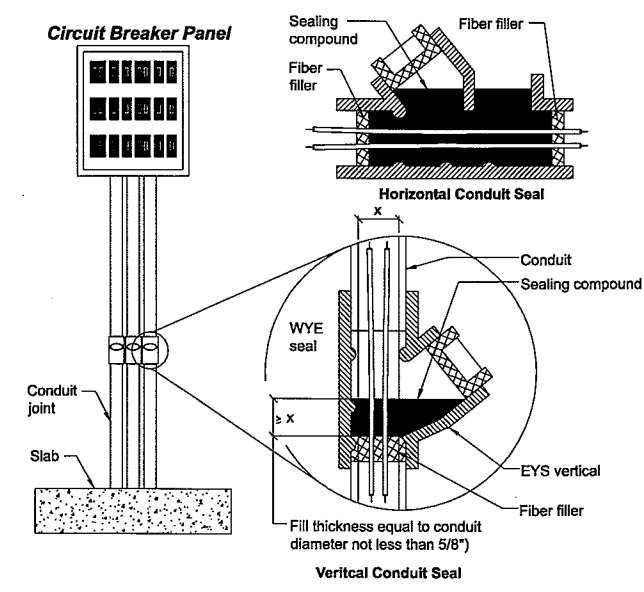
Membrane Termination at Garage Grade Beam **Detail 3**
Scale: Not to Scale



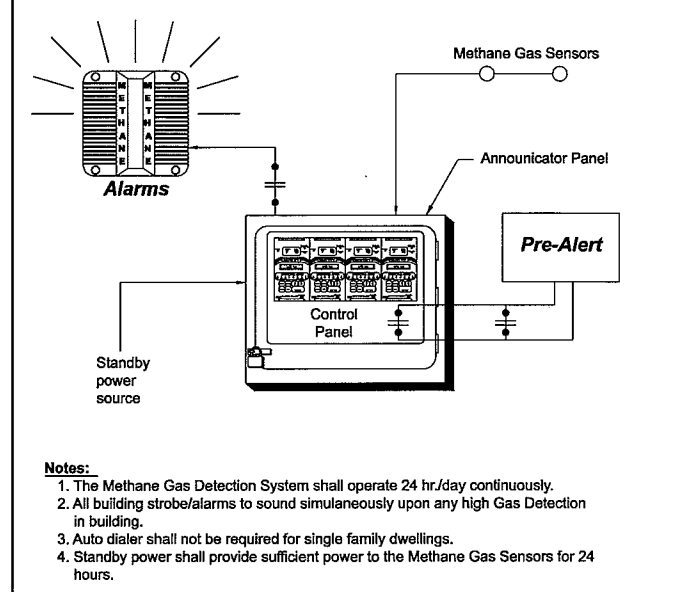
Membrane Termination at Exterior Footing - Two Pour **Detail 4**
Scale: Not to Scale



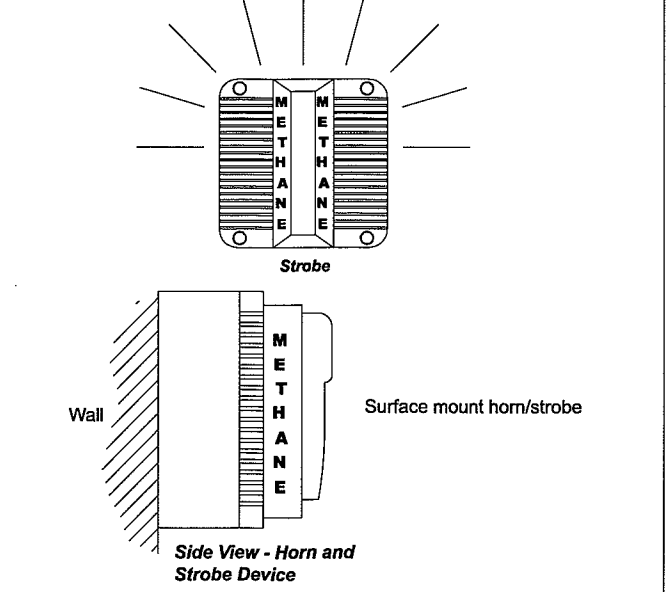
Membrane Boot **Detail 5**
Scale: Not to Scale



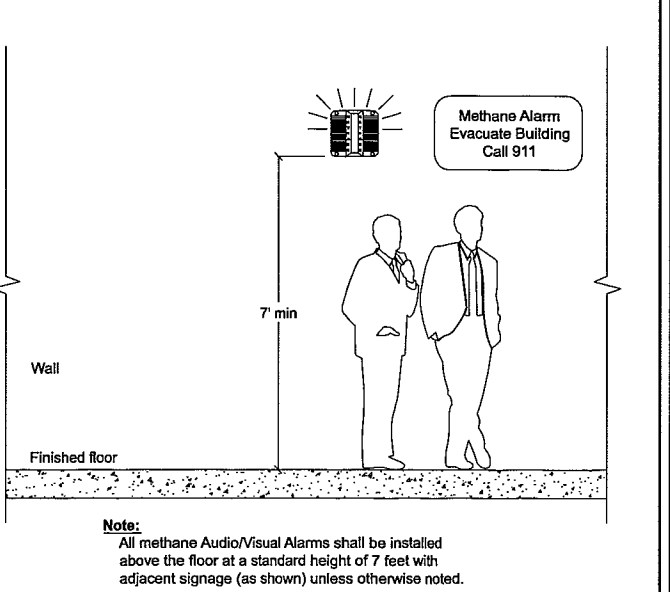
Vent Pipe at Interior Footing **Detail 6**
Scale: Not to Scale



Combination De-Watering and Vent Pipe **Detail 7**
Scale: Not to Scale



Membrane Boot **Detail 8**
Scale: Not to Scale



Conduit Seal **Detail 8**
Scale: Not to Scale

Methane Detection System **Detail 9**
Scale: Not to Scale

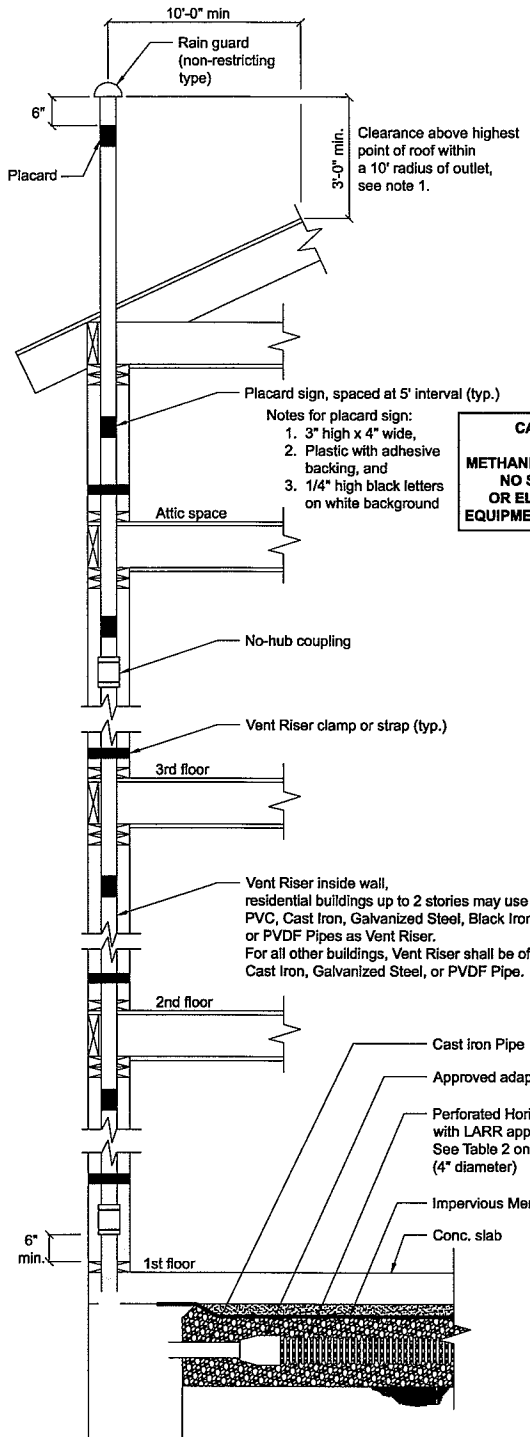
Methane Alarm Device - Horn and Strobe Combination **Detail 10**
Scale: Not to Scale

Methane Alarm Device Mount **Detail 11**
Scale: Not to Scale

SITE ADDRESS:
LEGAL DESCRIPTION:
OWNER:

STANDARD PLAN:
METHANE HAZARD MITIGATION
Not to be used for Playa Vista Projects

Rev. 1
Date: 02/01/06
Scale: Not to Scale
Drawn:
Job:
Sheet:



10'-0" min
Rain guard (non-restricting type)
6"
Placard
3'-0" min. Clearance above highest point of roof within a 10' radius of outlet, see note 1.

Placard sign, spaced at 5' interval (typ.)
Notes for placard sign:
1. 3" high x 4" wide,
2. Plastic with adhesive backing, and
3. 1/4" high black letters on white background

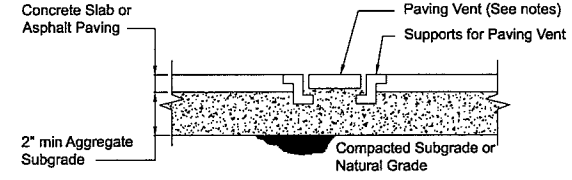
CAUTION
METHANE GAS IN PIPE
NO SMOKING
OR ELECTRICAL
EQUIPMENT WITHIN 10'

Vent Riser inside wall, residential buildings up to 2 stories may use PVC, Cast Iron, Galvanized Steel, Black Iron or PVDF Pipes as Vent Riser. For all other buildings, Vent Riser shall be of Cast Iron, Galvanized Steel, or PVDF Pipe.

Cast Iron Pipe
Approved adaptor (Femco)
Perforated Horizontal Pipe with LARR approval. See Table 2 on Sheet 4 for size, (4" diameter)
Impervious Membrane
Conc. slab

- Notes:**
- Termination of Vent Riser shall be as follows:
 - 10' min. above grade,
 - 10' min. away from any window, door, door hatch, opening or air intake into the building,
 - 3' min. above highest point of roof within a 10' radius of outlet,
 - 4' min away from property line, and
 - 5' min. away from electrical devices.
 - Wrap and protect all piping through concrete slab or floor.
 - Support all piping per Table 3-2 of Los Angeles Plumbing Code.

Vent Riser **Detail 12**
Scale: Not to Scale



- Notes:**
- Paving Vent shall be constructed on cast iron.
 - Paving Vent shall be installed at the same rate as the vent risers shown in Table 2 for corresponding openings.
 - Paving Vent shall be spaced a maximum of 100' apart.
 - Net area of openings in each Paving Vent shall be 12 square inches.

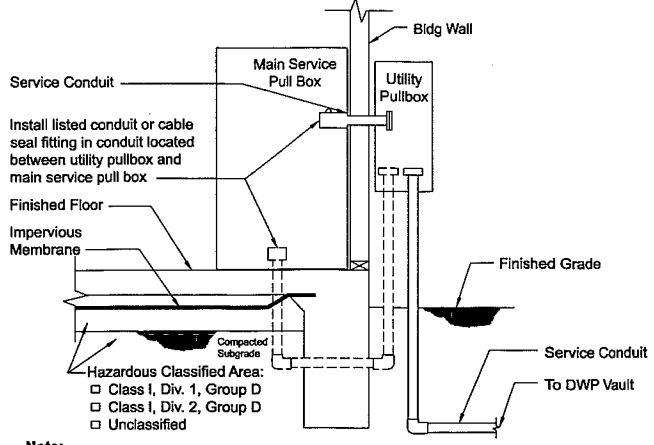
Paved Areas Venting **Detail 13**
Scale: Not to Scale

WARNING

THIS BUILDING IS PROTECTED WITH A METHANE GAS CONTROL BARRIER. ANY PROPOSED PENETRATION OR ALTERATION OF FLOOR SLAB REQUIRES NOTIFICATION OF THE BUILDING OFFICIAL AND INSPECTION BY AN ENGINEER

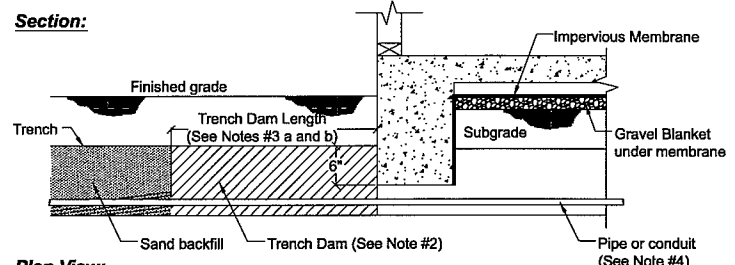
- Notes:**
- This notification is to be permanently stamped or etched in the surface of the garage slab or other location approved by the Building Inspector at the time of construction.
 - All letters 1/2" (min.) in height.
 - At least one required per building.
 - This notification shall be posted and maintained at the front entrance of the building, except residential buildings.

Gas Membrane notification placard **Detail 14**
Scale: Not to Scale

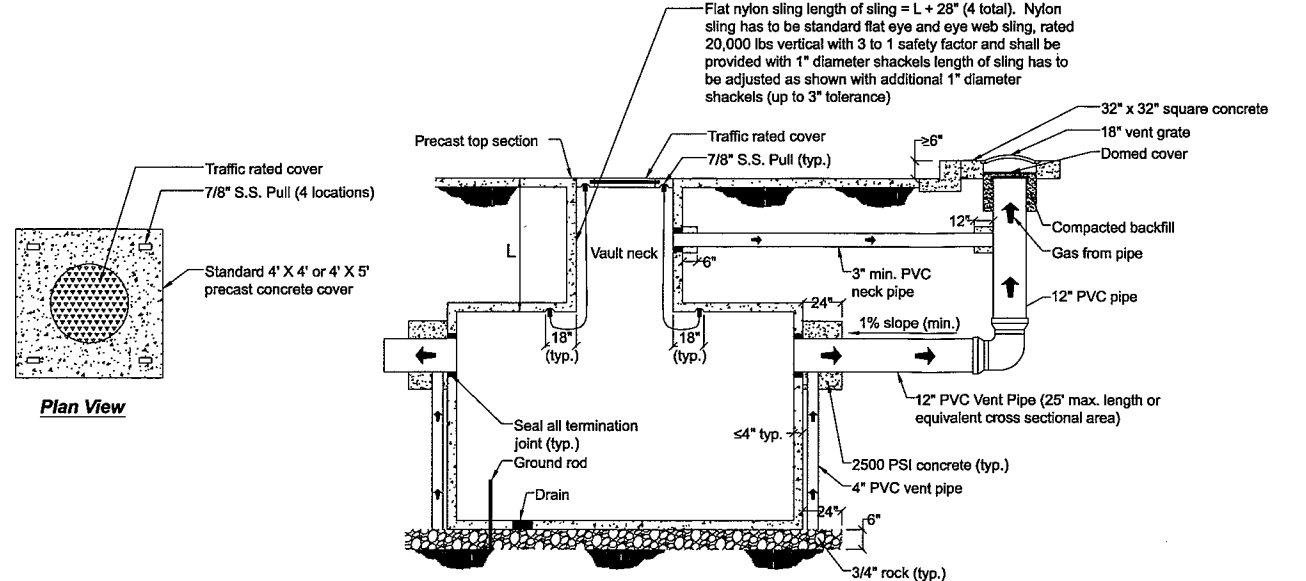


- Note:**
- Piping and conduit shall be protected from corrosion and structural settlement as follows:
 - Tape shall be applied on conduit and piping encased in cement slurry or concrete.
 - Tape shall be PS-37-90, Black Plastic PVC or PE Pressure - Sensitive Corrosion Preventive Tape.

Conduit or Cable Seal Fittings for Building Service and DWP Pull Boxes **Detail 15**
Scale: Not to Scale



Trench Dam **Detail 16**
Scale: Not to Scale



Large Underground Electrical Equipment Enclosures **Detail 18**
Scale: Not to Scale

SITE ADDRESS:
LEGAL DESCRIPTION:
OWNER:

STANDARD PLAN:
METHANE HAZARD MITIGATION
Not to be used for Playa Vista Projects

Rev.:
Date: 02/01/06
Scale: Not to Scale
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Job:
Sheet:

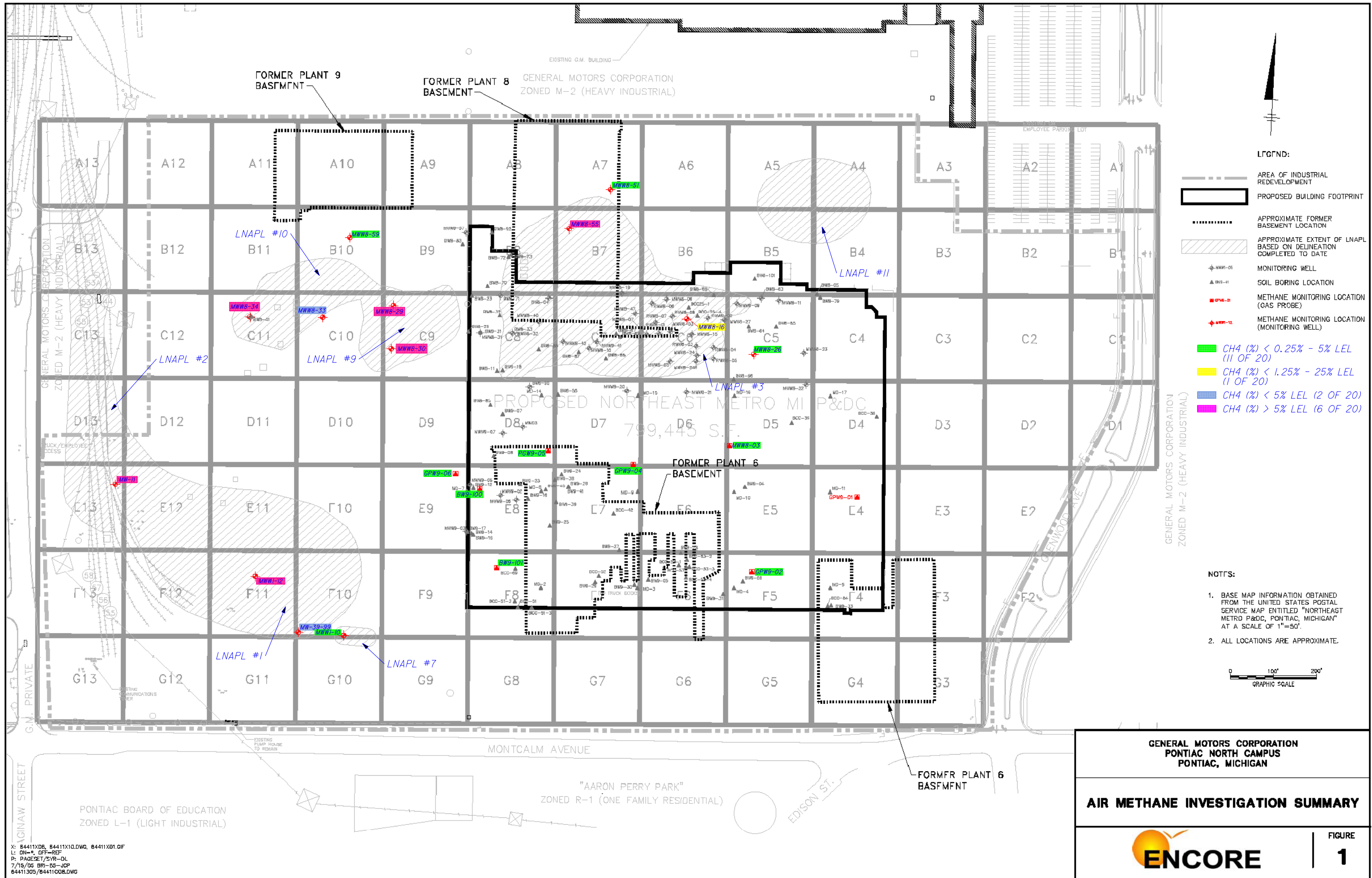
Summary of Methane Investigation Data

| | | | | | | |
|--------------------------------------------|---------|---------|---------|---------|---------|---------|
| Methane Measurement Point | MW39-99 | MWW1-10 | MWW1-12 | MW-11 | BW9-100 | BW9-101 |
| LNAPL Area No. | 1 | 7 | 1 | 1 | None | None |
| Site Grid | F-10 | F-10 | F-11 | E-13 | E8 | F8 |
| Within Building Footprint | No | No | No | No | Yes | Yes |
| Field Ave CH ₄ (%) | 2.21 | 0.10 | 7.23 | 8.39 | 0.04 | 0.10 |
| Field Pressure Ave (inch H ₂ O) | 0 | 0 | 0 | 0 | 0 | 0 |
| Bldg Design Level | NA | NA | NA | NA | II | II |
| Methane Measurement Point | MWW8-16 | MWW8-29 | MWW8-30 | MWW8-33 | MWW8-34 | MWW8-51 |
| LNAPL Area No. | 3 | 9 | 9 | 10 | 10 | 3 |
| Site Grid | C-6 | C-9 | C-9 | C-10 | C-11 | A-7 |
| Within Building Footprint | Yes | No | No | No | No | No |
| Field Ave CH ₄ (%) | 1.2 | 27.08 | 47.76 | 3.57 | 62.62 | 0.13 |
| Field Pressure Ave (inch H ₂ O) | 0 | 0 | 0.01 | 0.62 | 0.04 | 0.02 |
| Bldg Design Level | IV | NA | NA | NA | NA | NA |
| Methane Measurement Point | MWW8-26 | GPW9-02 | GPW9-03 | GPW9-04 | GPW9-05 | GPW9-06 |
| LNAPL Area No. | None | None | None | None | None | None |
| Site Grid | C-5 | F-5 | D-5 | D-7/E-7 | D-8 | E-9 |
| Within Building Footprint | Yes | Yes | Yes | Yes | Yes | No |
| Field Ave CH ₄ (%) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Field Pressure Ave (inch H ₂ O) | None | 0 | 0 | 0 | 0 | 0 |
| Bldg Design Level | I | I | I | I | I | NA |

Data Source: July 15, 2005, AIR Methane Investigation Summary by Encore Environmental Consortium, LLC

Assumptions:

Pressure Ave below zero set at zero.
 Recovery wells RWW8-13, RWW8-22, RWW8-28 and RWW8-32 were located within LNAPL Area No. 3 and are combined with MWW8-16.
 Data from July 1, 2005, not included in average, considered anomalous.
 Pressure data from MWW8-26 from June 28, 2005 excluded from analysis.
 Consistent monitoring point readings utilized were consistent and initial spike reading reported.



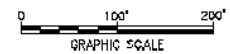
LEGEND:

- AREA OF INDUSTRIAL REDEVELOPMENT
- PROPOSED BUILDING FOOTPRINT
- APPROXIMATE FORMER BASEMENT LOCATION
- APPROXIMATE EXTENT OF LNAPL BASED ON DELINEATION COMPLETED TO DATE
- MONITORING WELL
- SOIL BORING LOCATION
- METHANE MONITORING LOCATION (GAS PROBE)
- ◆ METHANE MONITORING LOCATION (MONITORING WELL)

- CH₄ (%) < 0.25% - 5% LEL (11 OF 20)
- CH₄ (%) < 1.25% - 25% LEL (1 OF 20)
- CH₄ (%) < 5% LEL (2 OF 20)
- CH₄ (%) > 5% LEL (6 OF 20)

NOTES:

1. BASE MAP INFORMATION OBTAINED FROM THE UNITED STATES POSTAL SERVICE MAP ENTITLED "NORTHEAST METRO P&DC, PONTIAC, MICHIGAN" AT A SCALE OF 1"=50'.
2. ALL LOCATIONS ARE APPROXIMATE.



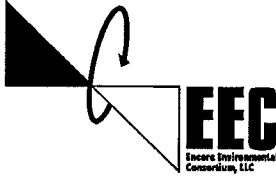
**GENERAL MOTORS CORPORATION
PONTIAC NORTH CAMPUS
PONTIAC, MICHIGAN**

AIR METHANE INVESTIGATION SUMMARY

FIGURE
1


X: 84411X08, 84411X10.DWG, 84411X01.CIF
 L: DN-*, OFF-REF
 P: PAGESET/SYR-DL
 7/15/05 BRI-BG-JCP
 84411305/84411008.DWG

MEMORANDUM



To: Peter Ramanaskaus/U.S. EPA

Date: 7/15/2005

From: Beth Landale/CRA 

cc: Robert Hare/ENCORE
Jean Caufield/ENCORE
Curt Wolfe/USPS
John McKenna/BBL
Gavin O'Neill/CRA

Re: AIR Methane Investigation Summary
Pontiac North Campus
Pontiac, Michigan

This memorandum summarizes the activities performed to investigate and delineate methane levels within the Area of Industrial Redevelopment (AIR) at Pontiac North Campus (Site) located in Pontiac, Michigan. The purpose of the investigation was to determine if methane is present in the AIR and to delineate the extent of methane beneath the proposed United States Postal Service (USPS) building footprint.

BACKGROUND

The USPS has identified concerns related to the potential for methane production from the historic fill areas within the AIR. The initial investigation monitored for the presence of methane in areas where historic filling activities were known to have occurred at the Site. Based on the initial results it was observed that the only methane readings coincided with the location of light non-aqueous phase liquid (LNAPL) present in LNAPL Areas Nos. 1, 2, and 7. The investigation was expanded to assess the presence of methane in wells installed within the LNAPL Areas 1, 2, 3, 7, 9, and 10. Methane was observed during the expanded investigation in LNAPL Areas Nos. 3, 9, and 10. Additional work was completed to confirm the methane levels detected and to verify whether anaerobic conditions were present in the subsurface. Delineation activities were completed within the footprint of the proposed USPS building to delineate methane beneath the proposed building.

The Scope of Work (SOW) for the methane investigations were presented in the following work plan memoranda:

- Area of Industrial Redevelopment (AIR) Methane Investigation Work Plan (EEC, March 17, 2005); and
- Draft AIR Methane Investigation Work Plan Addendum No.1 (EEC, June 24, 2005).

Methane monitoring procedures were completed consistent with the work plans. The scope of the investigations and the results are further discussed in the following sections.

SUMMARY OF ACTIVITIES

Initial Investigation

Two temporary soil gas probes (BW9-100 and BW9-101) were installed on March 17, 2005 to determine the presence and concentration of methane gas within the fill beneath the proposed building. Figure 1

presents the locations of the soil gas probes. The probes were constructed as indicated in Figure 2, with the bottom one foot of the screen located in the water table.

Four existing monitoring wells (MW39-99, MWW1-10, MWW1-12, and MW-11) located in the western area of the AIR (Grid areas E13, F11, and F10) were also used to monitor for methane within areas of fill located west of the proposed building. These monitoring wells had at least five feet of screen above the water table. The J-caps were replaced with stopcock and hose barb assemblies for gas monitoring. The locations of the existing monitoring wells and soil gas probes used to monitor methane are presented on Figure 1.

The probes and monitoring wells were monitored five days following the installation of the probes to allow pressure and methane to accumulate in the wells. Carbon dioxide (CO₂), oxygen (O₂), and methane gas measurements were obtained with a Landtec GA-90. The measured gas content was expressed as the equivalent percent methane by volume in air. Monitoring of the gage pressure at the monitoring locations was achieved using a digital manometer. The results of the initial monitoring are presented on Table 1.

Based on the initial results, additional monitoring was completed to verify the results and to evaluate the potential for methane in other areas of the AIR, specifically in the areas of the LNAPL pools. The monitoring included CO₂, O₂, methane, and pressure at eight additional monitoring wells in LNAPL Areas No. 3, 9, and 10 (MWW8-16, MWW8-29, MWW8-30, MWW8-33, MWW8-34, MWW8-51, MWW8-55, and MWW8-59) located in Grid areas A7, B8, B10, C6, C9, C10, and C11. The locations of these monitoring wells are presented on Figure 1. The gas measurements for the monitoring wells and soil gas probes are presented in Table 1.

Additional Work

Due to the presence of LNAPL in several of the wells where elevated methane readings were recorded, a field screening test was completed on May 4, 2005 to determine if volatile organic compounds (VOCs) could be interfering with the Landtec GA-90 meter. The wells were purged and initial methane readings were obtained. A small charcoal filter was then placed between the tubing and the Landtec GA-90 intake to remove/reduce any VOCs from the gas stream. The well/probe was purged for several more minutes to determine if the methane level measured by the Landtec GA-90 changed at all. No significant changes were observed. It did not appear that VOCs were interfering with the methane measurements.

To verify the methane concentrations measured using the Landtec GA-90, soil gas samples were collected and submitted to a local laboratory for methane analysis. Soil gas samples were collected from monitoring wells MWW1-12, MW-11, MWW8-29, MWW8-30, and MWW8-34 on May 31, 2005. Samples were collected using a portable air sampling pump and 1 liter laboratory supplied tedlar bags. The tedlar bags were filled three times at a pumping rate of 1 L/min to purge the well prior to collecting the sample for analysis. The samples were analyzed for methane using U.S. EPA Method SW846 8015 modified for air sample analysis. The results of the laboratory analysis confirmed the field measurement data. Table 2 summarizes the laboratory data and the associated field data collected on May 31, 2005, the date the laboratory samples were collected.

Based on the results of the initial and additional investigations, the cause of the methane production in the LNAPL areas is believed to be a result of anaerobic biodegradation of the LNAPL. To determine if the subsurface conditions favor the anaerobic biodegradation of LNAPL, groundwater parameters were

monitored including temperature, conductivity, dissolved oxygen, pH, and oxidation-reduction potential in 16 wells in the AIR. Groundwater was purged from each of the 16 monitoring wells using low-flow sampling protocol. Field parameter measurements were collected every five minutes until stabilization was achieved. The results generally indicate that subsurface (groundwater) conditions are anaerobic in the AIR. Four wells showed aerobic conditions. Two of these wells are located within the active area of the LNAPL No. 3 extraction system; one to the east, outside the extent of LNAPL Area No. 3; and one on the western edge of LNAPL Area 3 extended. The aerobic conditions, observed within the LNAPL No. 3 extraction area result from the injection of air as part of the removal process. Table 3 presents the field parameter results.

Addendum No. 1

To delineate methane gas beneath the rest of the proposed USPS building footprint, several soil gas probes were installed on June 27, 2005. Two soil gas probes (GPW9-01 and GPW9-02) were proposed to determine the presence and magnitude of methane gas beneath the southern and eastern portion of the proposed building footprint. The soil boring completed at the GPW9-01 location revealed dry clay from ground surface to 30 feet below ground surface, therefore a probe was not installed consistent with the Draft AIR Methane Investigation Work Plan, Addendum No. 1. An additional four soil gas probes (GPW9-03 through GPW9-06) were installed south of LNAPL Area No. 3 to delineate methane and migration potential beyond the footprint of LNAPL Area No. 3. An existing monitoring well (MWW8-26) with approximately 3.5 feet of screen above the water table in grid area C5, was used to monitor for methane east of LNAPL Area No. 3. The proposed USPS building footprint overlies the former Plant 6 Central Foundry location. The former Foundry included two large basements, which are located in grid areas E6 through E8 and F6 through F8. Soil gas probes were not installed within the former basement footprint as the materials contained in the basements are being removed. Figure 1 presents the locations of the additional soil gas probes and monitoring wells used to monitor for methane. The results of the methane delineation monitoring are presented in Table 1.

A methane reading of 3.3% by volume was observed at GPW9-02 during the third round of monitoring (five days following installation). Initial methane measurements recorded at GPW9-02 and subsequent readings did not detect methane. The 3.3% detection at GPW9-02 may be an anomaly.

Due to the active construction of the preload pile and the presence of an access road in the area, the four soil gas probes installed to delineate methane south of LNAPL Area No. 3 were installed further south than originally proposed. The additional methane monitoring beneath the building footprint indicated that methane was not present and was not migrating from LNAPL Area No. 3.

DISCUSSION

Based on the results of the monitoring, the fill material at the Site is not suspected to be a potential source of the methane. The methane production is related to the anaerobic biodegradation of the LNAPL present within the AIR. The additional methane monitoring below the proposed building footprint indicated that methane was not present beneath the building outside LNAPL Area No. 3 and was not migrating horizontally from LNAPL Area No. 3.

To evaluate the significance of the methane readings observed, the Michigan Department of Environmental Quality (MDEQ) Part 115, Act 451 Rule 299.4433 was used which regulates explosive gas control from

Type II landfills. This rule states that methane concentrations must remain below 25% of lower explosive limit (LEL). The LEL for methane is 5% by volume, therefore the screening criteria for this evaluation is 1.25% by volume of methane. The levels observed beneath the proposed building footprint are below this criterion, with the exception of the area directly above LNAPL Area No. 3.

It should be noted that previous soil borings completed by GM and USPS (i.e. McDowell) south and southeast of LNAPL Area No. 3 indicate that the geology is primarily lower permeability clays and silts and that a water bearing zone within more transmissive soils (e.g. sands) is not present. Based on the evaluation completed and the low permeability soils located beneath the proposed USPS building footprint, methane is not present beneath the building outside LNAPL Area No. 3 and has a low potential for horizontal migration.

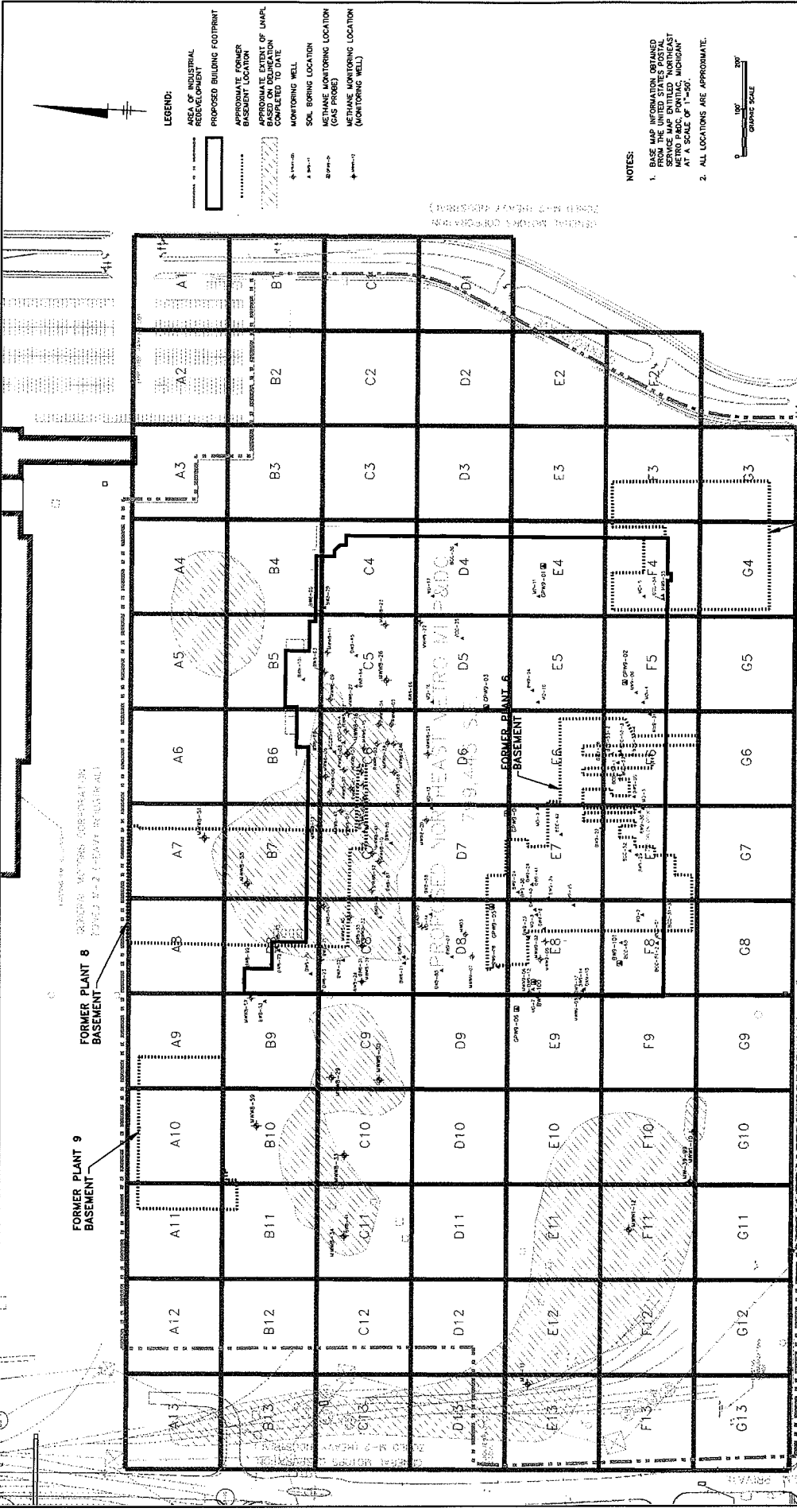
The continued recovery of free phase LNAPL from this area will further decrease the amount of LNAPL remaining in the subsurface and will also decrease the amount of methane being generated.

Methane is present at significant levels in LNAPL Areas Nos. 1, 2, 9, and 10, located in the AIR due to the anaerobic degradation of LNAPL in these areas. These areas are not located under the proposed USPS building footprint. Passive venting of methane in these areas can be easily accomplished.

SUMMARY

Based on data collected to-date, the methane detected in the AIR is a byproduct of anaerobic biodegradation of LNAPL located in the area. Based on the lower permeability clays and silts south of the LNAPL Area No. 3 and the lack of methane readings recorded from the gas probes installed within the building footprint, the methane produced in LNAPL Area No. 3 is not expected to migrate horizontally beneath the USPS building.

Engineering controls should be effective at managing methane production from residual LNAPL in the subsurface within the AIR.



GENERAL MOTORS CORPORATION
 PONTIAC NORTH CAMPUS
 PONTIAC, MICHIGAN

AIR METHANE INVESTIGATION SUMMARY



FIGURE
1

- NOTES:
- BASE MAP INFORMATION OBTAINED FROM THE UNITED STATES POSTAL SERVICE MAP ENTITLED "NORTHEAST PONTIAC, MICHIGAN" AT A SCALE OF 1"=500'
 - ALL LOCATIONS ARE APPROXIMATE.

FORMER PLANT 9 BASEMENT

FORMER PLANT 8 BASEMENT

FORMER PLANT 6 BASEMENT

VERTICAL AVENUE

WATER PERRY PARK

ZONED R-1 (ONE FAMILY RESIDENTIAL)

MORTGAGE BOARD OF BRACKEN ZONED L-1 (LIGHT INDUSTRIAL)

REARWAY STREET

N. EASTWOOD EASTING: 641100.07
 E. NORTHING: 16100.00
 UTM ZONE 18Q
 DATUM: NAD 83
 UNITS: METERS

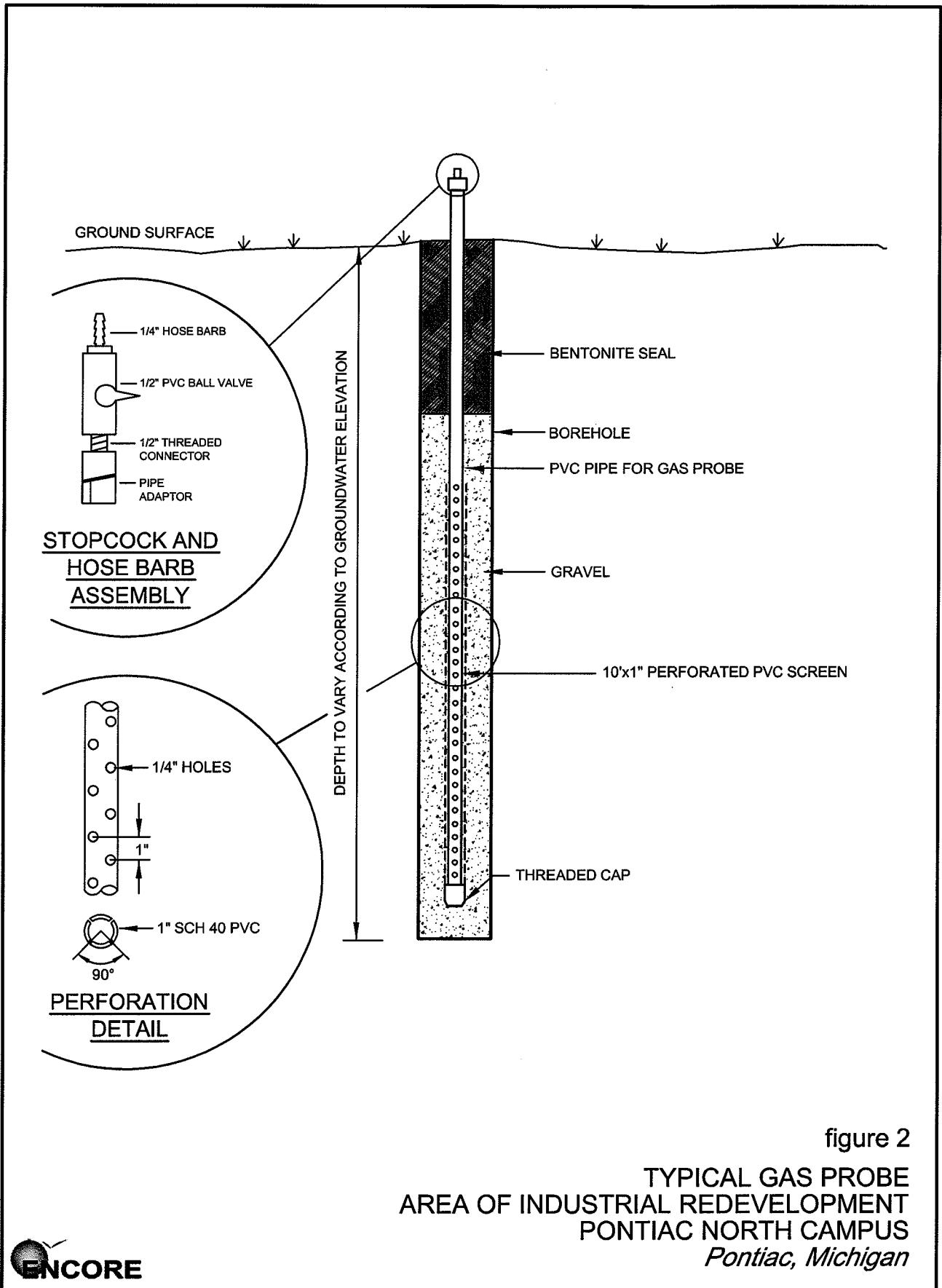


figure 2

TYPICAL GAS PROBE
 AREA OF INDUSTRIAL REDEVELOPMENT
 PONTIAC NORTH CAMPUS
Pontiac, Michigan



TABLE 1
SOIL GAS FIELD MEASUREMENTS
METHANE INVESTIGATION SUMMARY
PONTIAC NORTH CAMPUS
PONTIAC, MICHIGAN

| Well ID | Date | Pressure | CH ₄ (%) | CO ₂ (%) | O ₂ (%) | Notes |
|------------------------------------|---------|----------|---------------------|---------------------|--------------------|------------|
| <i>LNAPL Areas No. 1, 2, and 7</i> | | | | | | |
| MW39-99 | 3/23/05 | 0.04 | 2.9 | 4.1 | 0.0 | |
| | 3/24/05 | 0.03 | 2.4 | 3.2 | 2.4 | |
| | 4/4/05 | -- | 2.1 | 1.9 | 4.9 | |
| | 4/14/05 | -- | 3.7 | 2.3 | 0.2 | |
| | 4/15/05 | 0.01 | 3.1 | 2.2 | 5.6 | |
| | 5/4/05 | -0.65 | 0.3 | 0.0 | 22.0 | |
| | 5/19/05 | 0.12 | 1.0 | 1.9 | 7.7 | |
| MWW1-10 | 3/23/05 | 0.00 | 0.0 | 0.0 | 19.8 | |
| | 3/24/05 | 0.02 | 0.0 | 0.0 | 20.1 | |
| | 4/4/05 | -- | 0.0 | 0.0 | 19.8 | |
| | 4/14/05 | -- | 0.3 | 0.1 | 19.1 | |
| | 4/15/05 | -0.001 | 0.1 | 0.3 | 22.1 | |
| | 5/4/05 | -0.535 | 0.3 | 0.0 | 22.6 | |
| | 5/19/05 | -0.33 | 0.0 | 0.1 | 20.4 | |
| MWW1-12 | 3/23/05 | 0.05 | 11.3 | 0.0 | 0.9 | |
| | 3/24/05 | 0.05 | 10.5 | 0.0 | 1.9 | |
| | 4/4/05 | -- | 5.5 | 0.0 | 0.8 | |
| | 4/14/05 | -- | 2.4 | 0.0 | 0.3 | |
| | 4/15/05 | 0.01 | 1.8 | 0.3 | 0.4 | |
| | 5/4/05 | -0.710 | 1.2 | 0.0 | 4.2 | |
| | 5/19/05 | -0.270 | 16.1 | 0.0 | 0.0 | |
| | 5/31/05 | -- | 9.0 | 0.07 | 0.87 | |
| MW-11 | 3/23/05 | 0.07 | 11.8 | 4.1 | 0.6 | |
| | 3/24/05 | 0.03 | 10.5 | 4.2 | 0.5 | |
| | 4/4/05 | -- | 6.6 | 5.3 | 0.3 | |
| | 4/14/05 | -- | 2.3 | 6.4 | 0.4 | |
| | 4/15/05 | 0.001 | 0.0 | 7.1 | 5.2 | |
| | 5/4/05 | -0.385 | 9.8 (12.8) | 6.2 | 0.0 | |
| | 5/4/05 | -0.385 | 7.4 | 5.6 | 0.1 | (charcoal) |
| | 5/19/05 | -0.41 | 16.1 | 5.4 | 0.0 | |
| | 5/31/05 | -- | 11.0 | 6.5 | 0.7 | |
| BW9-100 | 3/23/05 | 0.01 | 0.0 | 4.9 | 5.0 | |
| | 3/24/05 | 0.00 | 0.0 | 4.3 | 6.2 | |
| | 4/4/05 | -- | 0.0 | 3.9 | 10.8 | |
| | 4/15/05 | 0.02 | 0.1 | 5.8 | 8.5 | |
| | 5/4/05 | -0.284 | 0.0 | 4.4 | 10.7 | |
| | 5/4/05 | -0.284 | 0.0 | 4.9 | 8.7 | (charcoal) |
| | 5/17/05 | -0.740 | 0.2 | 5.3 | 9.7 | |
| BW9-101 | 3/23/05 | 0.01 | 0.0 | 2.5 | 0.0 | |
| | 3/24/05 | 0.00 | 0.0 | 2.5 | 5.1 | |
| | 4/4/05 | -- | 0.0 | 2.5 | 0.1 | |
| | 4/15/05 | 0.01 | 0.1 | 3.5 | 0.0 | |
| | 5/4/05 | -0.655 | 0.3 | 3.7 | 0.0 | |
| | 5/17/05 | -0.060 | 0.3 (0.4) | 3.6 | 0.0 | |
| | 5/19/05 | 0.010 | 0.0 | 3.2 | 0.0 | |

TABLE 1
SOIL GAS FIELD MEASUREMENTS
METHANE INVESTIGATION SUMMARY
PONTIAC NORTH CAMPUS
PONTIAC, MICHIGAN

| Well ID | Date | Pressure | CH ₄ (%) | CO ₂ (%) | O ₂ (%) | Notes |
|-------------------------------------|---------|----------|---------------------|---------------------|--------------------|--------------------------------------|
| <i>LNAPL Areas No. 3, 9, and 10</i> | | | | | | |
| MWW8-16 | 4/18/05 | -39.40 | 0.3 | 0.0 | 21.5 | LNAPL Recovery System - operating |
| | 5/4/05 | -25.05 | 0.3 | 2.3 | 16.3 | LNAPL Recovery System - operating |
| | 5/19/05 | -0.01 | 0.6 | 0.0 | 21.0 | LNAPL Recovery System - operating |
| | 6/7/05 | - | 5.8 | 9.7 | 0.1 | LNAPL Recovery System - not operatir |
| MWW8-29 | 4/18/05 | 0.01 | 23.3 | 6.0 | 0.0 | |
| | 5/4/05 | -0.003 | 1.2 | 0.3 | 21.3 | |
| | 5/19/05 | -0.030 | 17.8 | 5.8 | 0.8 | |
| | 5/31/05 | - | 66.0 | 11.2 | 0.0 | |
| MWW8-30 | 4/18/05 | 0.10 | 71.0 | 7.3 | 5.1 | |
| | 5/4/05 | -0.02 | 56.0 | 7.0 | 5.7 | |
| | 5/4/05 | -0.02 | 57.7 | 5.8 | 6.3 | (charcoal) |
| | 5/19/05 | -0.01 | 10.8 | 1.2 | 18.5 | |
| | 5/31/05 | - | 43.3 | 5.1 | 9.6 | |
| MWW8-33 | 4/18/05 | 1.05 | 0.9 | 2.6 | 16.8 | |
| | 5/4/05 | 0.536 | 1.6 | 4.4 | 15.1 | |
| | 5/19/05 | 0.280 | 8.2 | 4.1 | 16.1 | |
| MWW8-34 | 4/18/05 | 0.11 | 70.0 | 4.4 | 0.0 | |
| | 4/19/05 | 0.09 | 72.0 | 4.5 | 0.0 | |
| | 5/4/05 | -0.01 | 58.9 | 4.9 | 0.0 | |
| | 5/4/05 | -0.01 | 58.9 | 4.2 | 0.0 | (charcoal) |
| | 5/19/05 | 0.04 | 57.8 | 4.5 | 0.0 | |
| | 5/31/05 | -0.008 | 58.1 | 4.4 | 0.0 | |
| MWW8-51 | 4/18/05 | 0.02 | 0.2 | 0.0 | 21.5 | |
| | 5/4/05 | 0.02 | 0.2 (0.8) | 0.0 | 22.3 | |
| | 5/19/05 | 0.03 | 0.0 | 0.0 | 21.3 | |
| MWW8-55 | 4/18/05 | 0.04 | 35.6 | 2.4 | 1.6 | |
| | 5/4/05 | 0.02 | 33.3 | 3.3 | 1.9 | |
| | 5/4/05 | 0.02 | 32.8 | 3.0 | 2.1 | (charcoal) |
| | 5/20/05 | 0.00 | 28.1 | 4.6 | 0.8 | |
| MWW8-59 | 4/18/05 | -0.01 | 0.1 | 0.0 | 21.3 | |
| | 5/4/05 | 0.02 | 0.2 | 0.0 | 22.0 | |
| | 5/19/05 | 0.01 | 0.0 | 0.0 | 21.8 | |
| <i>Other LNAPL Area No. 3</i> | | | | | | |
| MPE | 4/20/05 | - | 0.4 | 0.0 | - | |
| LNAPL Tank | 5/4/05 | - | 0.4 (0.8) | 0.0 | 18.9 | |
| RWW8-13 | 6/7/05 | - | 1.4 | 0.2 | 19.8 | LNAPL Recovery System - not operatir |
| RWW8-22 | 6/7/05 | - | 0.1 | 0.0 | 20.8 | LNAPL Recovery System - not operatir |
| RWW8-32 | 6/7/05 | - | 0.5 | 0.1 | 20.3 | LNAPL Recovery System - not operatir |
| RWW8-28 | 6/7/05 | - | 0.6 | 0.6 | 18.6 | LNAPL Recovery System - not operatir |

TABLE 1
SOIL GAS FIELD MEASUREMENTS
METHANE INVESTIGATION SUMMARY
PONTIAC NORTH CAMPUS
PONTIAC, MICHIGAN

| Well ID | Date | Pressure | CH ₄ (%) | CO ₂ (%) | O ₂ (%) | Notes |
|---------------------------|-----------|----------|---------------------|---------------------|--------------------|-------|
| <i>Building Footprint</i> | | | | | | |
| MWW8-26 | 6/28/2005 | 14.58 | 0.0 | 2.8 | 10.2 | |
| | 6/29/2005 | - | 0.0 | 2.1 (2.7) | 15.6 | |
| | 7/1/2005 | - | 0.2 | 1.5 | 19.0 | |
| | 7/5/2005 | - | 0.0 | 1.6 | 18.4 | |
| | 7/8/2005 | - | 0.0 | 1.5 | 18.6 | |
| GPW9-02 | 6/28/2005 | 0.00 | 0.0 | 1.0 | 19.3 | |
| | 6/29/2005 | -0.14 | 0.0 (0.3) | 2.2 (2.3) | 14.5 | |
| | 7/1/2005 | 0.02 | 3.3 | 1.7 | 13.1 | |
| | 7/5/2005 | -0.07 | 0.0 | 2.4 | 13.5 | |
| | 7/8/2005 | -0.05 | 0.0 | 2.5 | 13.8 | |
| GPW9-03 | 6/28/2005 | -0.03 | 0.0 | 0.0 | 20.3 | |
| | 6/29/2005 | -0.01 | 0.0 | 0.0 | 19.3 | |
| | 7/1/2005 | 0.00 | 0.0 | 0.0 | 15.9 | |
| | 7/5/2005 | -0.08 | 0.0 | 0.0 | 1.0 | |
| | 7/8/2005 | 0.00 | 0.0 | 0.0 | 0.9 | |
| GPW9-04 | 6/28/2005 | 0.01 | 0.0 | 0.4 | 19.1 | |
| | 6/29/2005 | -0.03 | 0.0 | 0.3 | 19.3 | |
| | 7/1/2005 | 0.01 | 0.3 | 6.1 | 0.3 | |
| | 7/5/2005 | -0.07 | 0.0 | 5.1 | 0.5 | |
| | 7/8/2005 | -0.06 | 0.0 | 4.4 | 0.6 | |
| GPW9-05 | 6/28/2005 | -0.01 | 0.0 | 0.0 | 9.2 | |
| | 6/29/2005 | -0.20 | 0.0 | 0.0 | 6.3 | |
| | 7/1/2005 | 0.03 | 0.2 | 0.0 | 2.1 | |
| | 7/5/2005 | -0.15 | 0.0 | 0.0 | 3.2 | |
| | 7/8/2005 | 0.01 | 0.0 | 0.0 | 4.0 | |
| GPW9-06 | 6/28/2005 | 0.08 | 0.0 (0.1) | 2.6 | 0.0 | |
| | 6/29/2005 | -0.20 | 0.0 | 2.7 | 0.0 | |
| | 7/1/2005 | 0.07 | 0.3 | 3.0 | 0.6 | |
| | 7/5/2005 | -0.05 | 0.0 | 2.8 | 0.0 | |
| | 7/8/2005 | 0.04 | 0.0 | 2.8 | 0.0 | |

Notes:

- % Percent by volume in air
- CO₂ Carbon dioxide
- CH₄ Methane
- O₂ Oxygen
- MPE Multiple Phase Extraction System
 - No reading collected, manometer or Landtec-90 not available or functioning.
- (#) Indicates a concentration spike observed during the purging of the well
- (charcoal) The air purged from the well was pumped through a charcoal filter before the Landtec-90
- Negative pressure in some cases may be due to the Multi-Phase Extraction System nearby

**TABLE 2
 LABORATORY RESULTS
 METHANE INVESTIGATION SUMMARY
 PONTIAC NORTH CAMPUS
 PONTIAC, MICHIGAN**

| Well ID | Date | CH ₄ (%) | |
|---------|---------|---------------------|------------|
| | | Field Reading | Laboratory |
| MWW1-12 | 5/31/05 | 9.0 | 10 |
| MW-11 | 5/31/05 | 11.0 | 11 |
| MWW8-29 | 5/31/05 | 66.0 | 62/52 |
| MWW8-30 | 5/31/05 | 43.3 | 48 |
| MWW8-34 | 5/31/05 | 58.1 | 58 |

Notes:

% Percent by volume in air

CH₄ Methane

62/52 Sample Result/Duplicate Result

TABLE 3
GROUNDWATER FIELD PARAMETERS
METHANE INVESTIGATION
PONTIAC NORTH CAMPUS
PONTIAC, MICHIGAN

| Well Code | Time Interval | Purge Rate (mL/min) | Water Level (feet BTOR) | Temperature (°C) | Conductivity (mS/Cm) | DO (mg/L) | pH | ORP (mV) |
|------------------------------------------------|---------------|---------------------|-------------------------|------------------|----------------------|-----------|-------|----------|
| MW-11 | 11:27 | 100 | 17.20 | 11.32 | 1.051 | 8.39 | 7.16 | -86 |
| | 11:32 | 100 | 17.21 | 11.93 | 1.052 | 8.14 | 7.14 | -86 |
| | 11:37 | 100 | 17.21 | 12.12 | 1.052 | 8.16 | 7.14 | -87 |
| <i>Note: large amount of bubbles in tubing</i> | | | | | | | | |
| MW39-99 | 14:54 | 100 | 26.65 | 13.97 | 0.956 | 0.37 | 7.91 | -153 |
| | 14:59 | 100 | 26.65 | 13.50 | 0.955 | 0.24 | 8.04 | -167 |
| | 15:04 | 100 | 26.65 | 13.40 | 0.945 | 0.19 | 8.13 | -181 |
| | 15:09 | 100 | 26.65 | 13.54 | 0.939 | 0.18 | 8.17 | -191 |
| | 15:14 | 100 | 26.65 | 13.44 | 0.936 | 0.15 | 8.24 | -197 |
| | 15:19 | 100 | 26.65 | 13.57 | 0.934 | 0.12 | 8.27 | -202 |
| | 15:24 | 100 | 26.65 | 13.63 | 0.933 | 0.12 | 8.27 | -205 |
| | 15:29 | 100 | 26.65 | 13.59 | 0.933 | 0.11 | 8.30 | -207 |
| MWW1-10 | 15:01 | 100 | 30.60 | 13.12 | 1.172 | 0.34 | 7.24 | -128 |
| | 15:06 | 100 | 30.81 | 13.12 | 1.145 | 0.19 | 7.19 | -131 |
| | 15:11 | 100 | 31.00 | 13.33 | 1.137 | 0.14 | 7.19 | -134 |
| | 15:16 | 100 | 31.24 | 13.33 | 1.138 | 0.11 | 7.20 | -138 |
| | 15:21 | 100 | 31.41 | 13.33 | 1.144 | 0.09 | 7.21 | -139 |
| | 15:26 | 100 | 31.60 | 13.48 | 1.149 | 0.08 | 7.23 | -142 |
| | 15:31 | 100 | 31.72 | 13.47 | 1.165 | 0.07 | 7.27 | -144 |
| MWW1-12 | 11:45 | 100 | 17.02 | 10.28 | 0.355 | 0.36 | 11.17 | -93 |
| | 11:50 | 100 | 17.00 | 10.49 | 0.358 | 0.28 | 11.17 | -98 |
| | 11:55 | 100 | 17.00 | 10.47 | 0.363 | 0.32 | 11.18 | -107 |
| | 12:00 | 100 | 17.00 | 10.53 | 0.365 | 0.26 | 11.17 | -111 |
| | 12:05 | 100 | 16.99 | 10.59 | 0.365 | 0.24 | 11.16 | -114 |
| | 12:10 | 100 | 16.99 | 10.66 | 0.365 | 0.24 | 11.14 | -117 |
| MWW8-30 | 11:30 | 100 | 11.19 | 14.23 | 5.12 | 0.45 | 6.50 | -82 |
| | 11:35 | 100 | 11.19 | 13.47 | 5.15 | 0.33 | 6.51 | -84 |
| | 11:40 | 100 | 11.19 | 14.18 | 5.14 | 0.31 | 6.52 | -85 |
| | 11:45 | 100 | 11.19 | 14.12 | 5.15 | 0.26 | 6.54 | -87 |
| | 11:50 | 100 | 11.19 | 13.47 | 5.15 | 0.24 | 6.54 | -87 |
| | 11:55 | 100 | 11.19 | 13.32 | 5.17 | 0.22 | 6.54 | -87 |
| MWW8-33 | 17:13 | 100 | 20.46 | 12.71 | 5.24 | 0.12 | 7.64 | -132 |
| | 17:18 | 100 | 20.47 | 12.77 | 5.24 | 0.12 | 7.65 | -134 |
| | 17:23 | 100 | 20.48 | 12.72 | 5.23 | 0.12 | 7.64 | -137 |
| MWW8-34 | 16:30 | 100 | 18.15 | 12.16 | 4.47 | 0.11 | 7.10 | -185 |
| | 16:35 | 100 | 18.15 | 12.36 | 4.45 | 0.10 | 7.10 | -194 |
| | 16:40 | 100 | 18.15 | 12.38 | 4.44 | 0.08 | 7.10 | -200 |
| | 16:45 | 100 | 18.15 | 12.41 | 4.43 | 0.08 | 7.11 | -205 |
| | 16:50 | 100 | 18.15 | 12.40 | 4.43 | 0.07 | 7.11 | -210 |
| MWW8-35 | 14:38 | 100 | 15.53 | 13.29 | 1.93 | 0.23 | 7.02 | -110 |
| | 14:43 | 100 | 15.53 | 13.06 | 1.91 | 0.19 | 7.05 | -113 |
| | 14:48 | 100 | 15.53 | 13.01 | 1.93 | 0.18 | 7.06 | -115 |
| | 14:53 | 100 | 15.53 | 13.08 | 1.94 | 0.15 | 7.08 | -117 |
| | 14:58 | 100 | 15.53 | 12.92 | 1.95 | 0.14 | 7.10 | -121 |
| | 15:03 | 100 | 15.53 | 13.08 | 1.95 | 0.13 | 7.10 | -122 |
| MWW8-37 | 11:28 | 100 | 20.18 | 13.17 | 2.06 | 0.33 | 7.20 | -140 |
| | 11:33 | 100 | 20.18 | 13.30 | 2.06 | 0.22 | 7.23 | -145 |
| | 11:38 | 100 | 20.18 | 13.32 | 2.07 | 0.21 | 7.25 | -147 |
| | 11:43 | 100 | 20.18 | 13.26 | 2.07 | 0.19 | 7.26 | -150 |
| | 11:48 | 100 | 20.18 | 13.07 | 2.07 | 0.16 | 7.28 | -152 |
| | 11:53 | 100 | 20.18 | 13.07 | 2.07 | 0.16 | 7.28 | -152 |
| | 11:58 | 100 | 20.18 | 13.10 | 2.07 | 0.15 | 7.28 | -152 |

**TABLE 3
GROUNDWATER FIELD PARAMETERS
METHANE INVESTIGATION
PONTIAC NORTH CAMPUS
PONTIAC, MICHIGAN**

| Well Code | Time Interval | Purge Rate (mL/min) | Water Level (feet BTOR) | Temperature (°C) | Conductivity (mS/Cm) | DO (mg/L) | pH | ORP (mV) |
|----------------------------------------------------------------------|---------------|---------------------|-------------------------|------------------|----------------------|-----------|------|----------|
| MWW8-45 | 14:35 | 100 | 20.52 | 14.11 | 1.61 | 0.65 | 6.83 | -228 |
| | 14:40 | 100 | 20.52 | 13.60 | 1.61 | 0.27 | 6.85 | -237 |
| | 14:45 | 100 | 20.52 | 13.51 | 1.60 | 0.18 | 6.86 | -247 |
| | 14:50 | 100 | 20.52 | 13.50 | 1.60 | 0.13 | 6.87 | -219 |
| | 14:55 | 100 | 20.52 | 13.52 | 1.59 | 0.11 | 6.87 | -251 |
| | 15:00 | 100 | 20.52 | 13.51 | 1.59 | 0.09 | 6.88 | -254 |
| | 15:10 | 100 | 20.52 | 13.42 | 1.59 | 0.08 | 6.88 | -257 |
| | 15:20 | 100 | 20.52 | 13.34 | 1.59 | 0.07 | 6.89 | -261 |
| | 15:30 | 100 | 20.52 | 13.75 | 1.58 | 0.06 | 6.89 | -266 |
| | 15:35 | 100 | 20.52 | 13.78 | 1.58 | 0.05 | 6.89 | -268 |
| | 15:40 | 100 | 20.52 | 14.13 | 1.58 | 0.05 | 6.89 | -268 |
| MWW8-59 | 17:28 | 100 | 26.38 | 14.24 | 1.14 | 0.51 | 6.63 | -48 |
| | 17:33 | 100 | 26.38 | 14.18 | 1.14 | 0.47 | 6.63 | -49 |
| | 17:38 | 100 | 26.38 | 14.26 | 1.145 | 0.42 | 6.63 | -53 |
| | 18:43 | 100 | 26.38 | 14.30 | 0.991 | 0.41 | 6.64 | -55 |
| MWW8-26 | 10:25 | 100 | 14.73 | 12.67 | 1.423 | 4.64 | 6.47 | 234 |
| | 10:30 | 100 | 14.73 | 12.93 | 1.424 | 4.43 | 6.58 | 226 |
| | 10:35 | 100 | 14.73 | 12.17 | 1.426 | 4.67 | 6.60 | 222 |
| | 10:40 | 100 | 14.73 | 11.61 | 1.424 | 5.08 | 6.62 | 219 |
| | 10:45 | 100 | 14.73 | 11.70 | 1.425 | 5.12 | 6.64 | 215 |
| <i>Note: located outside of and east of LNAPL Area No. 3</i> | | | | | | | | |
| MWW8-51 | 15:15 | 200 | 5.99 | 13.93 | 1.294 | 1.19 | 6.70 | -83 |
| | 15:20 | 200 | 5.99 | 13.82 | 1.293 | 0.64 | 6.73 | -98 |
| | 15:30 | 200 | 5.99 | 14.73 | 1.296 | 0.42 | 6.77 | -107 |
| | 15:35 | 200 | 5.99 | 14.62 | 1.295 | 0.38 | 6.79 | -110 |
| | 15:40 | 200 | 5.99 | 14.81 | 1.305 | 0.33 | 6.79 | -113 |
| | 15:45 | 200 | 5.99 | 14.64 | 1.313 | 0.30 | 6.78 | -115 |
| MWW8-53 | 12:05 | 200 | 20.74 | 15.30 | 1.64 | 3.24 | 6.51 | 161 |
| | 12:10 | 200 | 20.74 | 14.96 | 1.63 | 2.02 | 6.62 | 146 |
| | 12:15 | 200 | 20.74 | 14.41 | 1.62 | 2.65 | 6.63 | 137 |
| | 12:20 | 200 | 20.74 | 14.85 | 1.63 | 2.53 | 6.63 | 128 |
| | 12:25 | 200 | 20.74 | 15.09 | 1.63 | 2.4 | 6.64 | 119 |
| | 12:30 | 200 | 20.74 | 14.61 | 1.64 | 2.36 | 6.65 | 112 |
| | 12:35 | 200 | 20.74 | 14.73 | 1.64 | 2.36 | 6.65 | 105 |
| | 12:40 | 200 | 20.74 | 15.12 | 1.64 | 2.35 | 6.66 | 100 |
| | 12:45 | 200 | 20.74 | 15.20 | 1.64 | 2.35 | 6.65 | 97 |
| <i>Note: located on western edge of LNAPL Area No. 3</i> | | | | | | | | |
| RWW8-32 | 10:00 | 500 | 31.10 | 14.16 | 1.333 | 1.13 | 6.73 | 54 |
| | 10:05 | 500 | 31.10 | 15.61 | 1.315 | 0.62 | 6.79 | 27 |
| | 10:10 | 500 | 31.10 | 15.72 | 1.315 | 0.57 | 6.8 | 20 |
| | 10:15 | 500 | 31.10 | 15.77 | 1.328 | 0.54 | 6.83 | 22 |
| | 10:20 | 500 | 31.10 | 15.88 | 1.329 | 0.53 | 6.83 | 25 |
| | 10:25 | 500 | 31.10 | 15.84 | 1.330 | 0.47 | 6.84 | 27 |
| <i>Note: located within LNAPL Area No. 3 active remediation area</i> | | | | | | | | |
| RWW8-14 | 13:15 | 500 | 31.20 | 14.26 | 1.165 | 4.71 | 7.85 | 103 |
| | 13:20 | 500 | 31.20 | 15.25 | 1.192 | 3.59 | 7.90 | 101 |
| | 13:25 | 500 | 31.20 | 15.51 | 1.175 | 3.15 | 7.92 | 100 |
| | 13:30 | 500 | 31.20 | 15.76 | 1.171 | 2.92 | 7.93 | 100 |
| | 13:35 | 500 | 31.20 | 15.93 | 1.181 | 2.74 | 7.92 | 99 |
| <i>Note: located within LNAPL Area No. 3 active remediation area</i> | | | | | | | | |

Notes:
 BTOR Below Top of Riser
 DO Dissolved Oxygen
 ORP Oxidation Reduction Potential
 Measurements collected in May 2005.

III. Design Site Specific System Based Upon Base Method and Site Specific Data

Review of the site specific methane data relative to the potential design criteria was completed. The data from the monitoring points within the proposed building footprint were compared to the mitigation requirements for methane zone from the selected base method. This evaluation is reflected on Table 1A, which follows. A total of seven of the eight monitoring points exhibit data indicative of a Level I or II design level, while one of the eight monitoring points exhibits data indicative of a Level IV design level. The Level IV design level data is located within the proposed building footprint in the area of LNAPL Area No. 3, in environmental grid location C6, which is located within the northwest quadrant of the proposed building footprint. Within the proposed building footprint the aerial extent of LNAPL Area 3 is approximately 120,000 square feet, all located within the northwest quadrant. The total proposed building footprint area is approximately 800,000 square feet. Therefore, the associated design level for the building is: (1) Level IV for approximately 120,000 square feet in the northwest quadrant of the building; and, (2) Level I or II for approximately 680,000 square feet in the northeast, southeast and southwest quadrants of the building.

A passive system typically includes dewatering, a sub-slab vent system and an impervious membrane. Based upon the depth of ground water at the site, a de-watering system is unnecessary. A sub-slab vent system consisting of perforated horizontal pipes and a gravel blanket with gravel around the perforated horizontal pipes and vent risers is appropriate. Identified sub-slab vent system details are listed below. An impervious membrane is appropriate beneath the building slab. A gas tight seal is necessary for penetrations and footing connections. Proper installation and protection of the impervious membrane is necessary to maintain a gas tight seal.

- Perforated Horizontal Pipes - Minimum Schedule 40 4-inch diameter perforated PVC with a maximum horizontal pipe spacing of 100 feet.
- Gravel Blanket - Minimum 2-inches of clean MDOT Class II sand.
- Gravel Around Perforated Horizontal Pipes - Minimum 2-inches of clean MDOT Class II sand surrounding pipe with pipe wrapped in geotextile fabric.
- Vent Riser Pipes - Minimum 4-inch diameter cast iron pipe. For Level IV design area, vent risers spaced at 100 feet. For Level I or II design area, vent riser stubs spaced at 100 feet.
- Vent Riser Location Requirements - At least: 10 feet above grade; 10 feet from any windows, doors, opening, air intake, etc.; 3 feet above the highest roof point within 10 feet of the outlet; 3 feet away from any parapet; 4 feet from the property line; and, 5 feet away from any electrical device.

An active system typically includes detection components, mechanical extraction and mechanical ventilation. Since there are separate design levels for the building, different active system components are suitable to different areas within the building.

For the Level I and II design area there is no identified need for active system components. Therefore, mechanical extraction, detection components (pressure sensors, gas detectors, and alarm systems) and mechanical ventilation are not mandatory system components.

For the Level IV design area there is no identified need for mechanical extraction or select detection components (pressure sensors). However, some detection components (gas detectors

and alarm systems) and mechanical ventilation are appropriate systems for the lowest occupied space (i.e., elevator shafts, sump pits, etc.).

A. Passive System Expansion Potential

The configuration of the Level I and II design area incorporates vent riser stubs to allow for future extension. This passive system expansion potential is provided in the event methane or pressure levels increase. This expansion potential enables the Level I and II design area system to be converted to match the Level IV design area system by: (1) extending the vertical risers through the roof; and, (2) adding some detection components (gas detectors and alarm systems) and mechanical ventilation selected areas.

B. Active System Modification Potential

The configuration of the system incorporates a primary header pipe in separate zones, which will allow for future modification to an active system. This active system modification potential is provided in the event methane or pressure levels increase. This modification potential enables the system to be converted to a Level V design area system by: (1) providing mechanical extraction (blowers); and, (2) adding some detection components (pressure sensors).

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REVIEW SYSTEM ELEMENTS PER BASE METHOD

DESIGN REQUIREMENTS

Table 1A - MITIGATION REQUIREMENTS FOR METHANE ZONE (See note 1)

| Site Design Level | | Level I | | Level II | | Level III | | Level IV | | Level V | |
|--------------------------------------------------|----------------------------------------------------------|----------------------------------------------------|------|-------------|------|---------------|------|----------------|------|--------------|----|
| Design Methane Concentration (ppmv) | | 0 - 100 | | 101 - 1,000 | | 1,001 - 5,000 | | 5,001 - 12,500 | | > 12,500 | |
| Design Methane Pressure (inches of water column) | | ≤ 2" | > 2" | ≤ 2" | > 2" | ≤ 2" | > 2" | ≤ 2" | > 2" | All Pressure | |
| PASSIVE SYSTEM | De-watering System | X | X | X | X | X | X | X | X | X | |
| | Sub-Slab Vent System | Perforated Horizontal Pipes | X | X | X | X | X | X | X | X | X |
| | | Gravel Blanket Thickness Under Impervious Membrane | 2" | 2" | 2" | 3" | 2" | 3" | 2" | 4" | 4" |
| | Gravel Thickness Surrounding Perforated Horizontal Pipes | 2" | 2" | 2" | 3" | 2" | 3" | 2" | 4" | 4" | |
| | Vent Risers | X | X | X | X | X | X | X | X | X | |
| | Impervious Membrane | X | X | X | X | X | X | X | X | X | |
| ACTIVE SYSTEM | Sub-Slab Vent System | Pressure Sensors Below Impervious Membrane | | | | | | | X | X | |
| | | Mechanical Extraction System | | | | | | | X | X | |
| | Lowest Occupied Space System | Gas Detection System | | X | | X | X | X | X | X | X |
| | | Mechanical Ventilation | | X | | X | X | X | X | X | X |
| | | Alarm System | | X | | X | X | X | X | X | X |
| Control Panel | | X | | X | X | X | X | X | X | | |
| MISC. SYSTEM | Trench Dam | X | X | X | X | X | X | X | X | X | |
| | Conduit or Cable Seal Fitting | X | X | X | X | X | X | X | X | X | |
| | Additional Vent Risers (See note 4) | | | | | | | | | X | |

MHW B-26
 GPW 9-02
 GPW 9-03
 GPW 9-04
 GPW 9-05
 (5 of 8)

BW 9-100
 BW 9-101
 (2 of 8)

LNAPL AREA No. 3
 MHW B-16 AND RECOVERY WELLS
 (1 of 8)

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VENT SPACING

Table 2 - SPACING OF PERFORATED HORIZONTAL PIPES AND NUMBER OF VENT RISERS

| VENT RISER PIPE DIAMETER (inches) | MAX. SUB-SLAB PERFORATED HORIZONTAL PIPE SPACING (feet) | MAX. SUB-SLAB COMBINATION PERFORATED HORIZONTAL PIPE FOR DEWATERING AND VENT SPACING (feet) | NUMBER OF VENT RISER PER BUILDING FOOTPRINT AREA (square feet) |
|-----------------------------------|---------------------------------------------------------|---------------------------------------------------------------------------------------------|----------------------------------------------------------------|
| 1 1/2 | 12.5 | Not allowed | 1/1,250 (min of 2 risers) |
| 2 | 25 | Not allowed | 1/2,500 (min of 2 risers) |
| 2 1/2 | 50 | Not allowed | 1/5,000 (min of 3 risers) |
| 3 | 75 | Not allowed | 1/7,500 (min of 4 risers) |
| 4 | 100 | 50 | 1/10,000 (min of 4 risers) |

NOTE:

- Riser length shall be a maximum of 100' measured along pipe (including bends).
- Vent Risers max spacing shall be 100' measured along horizontal pipes.
- When the application of the spacing and location requirement of this table results in the requirement of a fractional number of Vent Risers, any fraction shall be construed as one Vent Riser.
- Horizontal pipes shall always be equal or larger in diameter than the vertical risers.
- Building Footprint shall be defined as the area in square feet contained within the exterior walls at or below the grade level.
- Vent Risers shall be located as per the above table for buildings with footprint areas covering up to 100,000 square feet.
- Vent Risers in buildings with footprint area covering over 100,000 square feet may use the minimum standards in the above table or an alternate method justified by engineering calculations approved by the LADBS. ←

LEVEL IV DESIGN AREA

MAX. HORIZONTAL SPACING 100 FEET
 VENT RISERS MIN. 12 (120,000 SF / 10,000 SF)

LEVEL I AND II DESIGN AREA

MAX. HORIZONTAL SPACING 100 FEET
 VENT RISERS STUBS MIN. 68 (680,000 SF / 10,000 SF)
 VENT RISERS SELECTED FROM STUBS AS APPROPRIATE

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DETECTOR SPACING

Table 6 - DETECTOR SPACING

| ROOM FLOOR AREA OR CONCEALED SPACE AREA (square feet) | NUMBER OF DETECTORS * | |
|-------------------------------------------------------|-------------------------------------------------------------------------------------------|----------------------------------------------------------------------|
| | WITH HEATING, VENTILATION AND AIR CONDITIONING | WITHOUT HEATING, VENTILATION AND AIR CONDITIONING |
| 10,000 and More | Minimum of 3 Detectors plus one for every 20,000 and fraction thereof in excess of 10,000 | Minimum of 6 Detectors plus one for every 2,500 and fraction thereof |
| More Than 5,000 and Less Than 10,000 | 3 Detectors | Minimum of 2 Detectors plus one for every 2,500 and fraction thereof |
| More Than 1,000 and Up to 5,000 | 2 Detectors | Minimum of 1 Detector plus one for every 2,500 and fraction thereof |
| 0 and Up to 1,000 | 1 Detector | 1 Detector |

NOTE:
 * In addition to the required number of Detectors in this table, there shall be at least one Detector in each elevator shaft and enclosed stairway.

LEVEL IV DESIGN AREA (GAS DETECTORS APPROPRIATE) ≈ 120,000 SF

∴ 3 DETECTORS PLUS 120,000 SF / (1 DETECTOR / 20,000 SF)
 = 9 DETECTORS

SAY 10 DETECTORS (PLUS AS NEEDED FOR SHAFTS, STAIRWAYS, ETC.)

IV. Potential Gas Generation and Design System Capacity

The suspected source of methane generation is the identified on-site LNAPLs. LNAPL Area No. 3 is the lone LNAPL with any area beneath the proposed building footprint. Approximately 120,000 square feet of LNAPL Area No. 3 is located beneath the proposed building footprint. The reported primary constituents of this LNAPL include Fuel Oil Nos. 2 and 6. These fuel oils are relatively resistant to biodegradation and the resultant methane generation. Accordingly, anticipated methane generation from at the project site is relatively low. A calculation of potential methane generation from the LNAPL Area No. 3 beneath the proposed building footprint follows.

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SHEET NO 1 OF 2
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Estimate flammable vapor intrusion from non-aqueous phase free product below building.

Assumptions

1. Product layer 3 ft thick located 25 ft below grade on shallow groundwater surface,
2. Product is weathered diesel #2 and highly degraded #6 fuel oil, 50% each,
3. 800,000 sf building on a slab,
4. 120,000 sf impacted area under building
5. Soil porosity = 0.30,
6. Ground water surface rises and falls 3 ft twice per year
7. All vapor emissions enter the building.

Note: Methane measurements by Roux Associates in soil above a free product plume showed negligible methane at distances greater than 15 feet above the free product. (See Figure 6)

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Model Vapor Evaporation as working loss from a fixed roof tank (AP-42, Chapter 7)

$$L_w = 0.0010 M_v P_{VA} Q K_N K_p \quad \text{Eq. 1-23}$$

Model as 100% fresh distillate No 2
 Properties from Table 7.1-2

M_v = vapor molecular weight = 130 lb/lb-mole

P_{VA} = vapor pressure at liquid temperature
 (assume 50°F)

$$= 0.0045 \text{ psi}$$

$$Q = \text{annual net throughput (bbl/yr)}$$

$$= \text{porosity} \left(\frac{120,000 \text{ sf}}{42 \text{ gal/bbl}} \right) (35 \text{ ft}) (7.48 \frac{\text{gal}}{\text{ft}^3}) (2/\text{yr})$$

$$= 38,469 \text{ bbl/yr} \quad (\text{TP})$$

K_N = turnover factor, dimensionless
 = 1 (less than 36 turnovers/yr)

K_p = working loss product factor, dimensionless
 = 1 (for organic liquids other than crude oil)

$$L_w = 0.0010 (130)(0.0045)(38,469)(1)(1) = 22.5 \text{ lb/yr} \quad (\text{TP})$$

∴ Vapor Intrusion estimated at 22.5 lb/yr

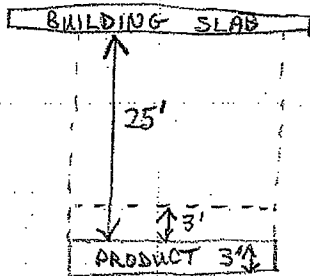
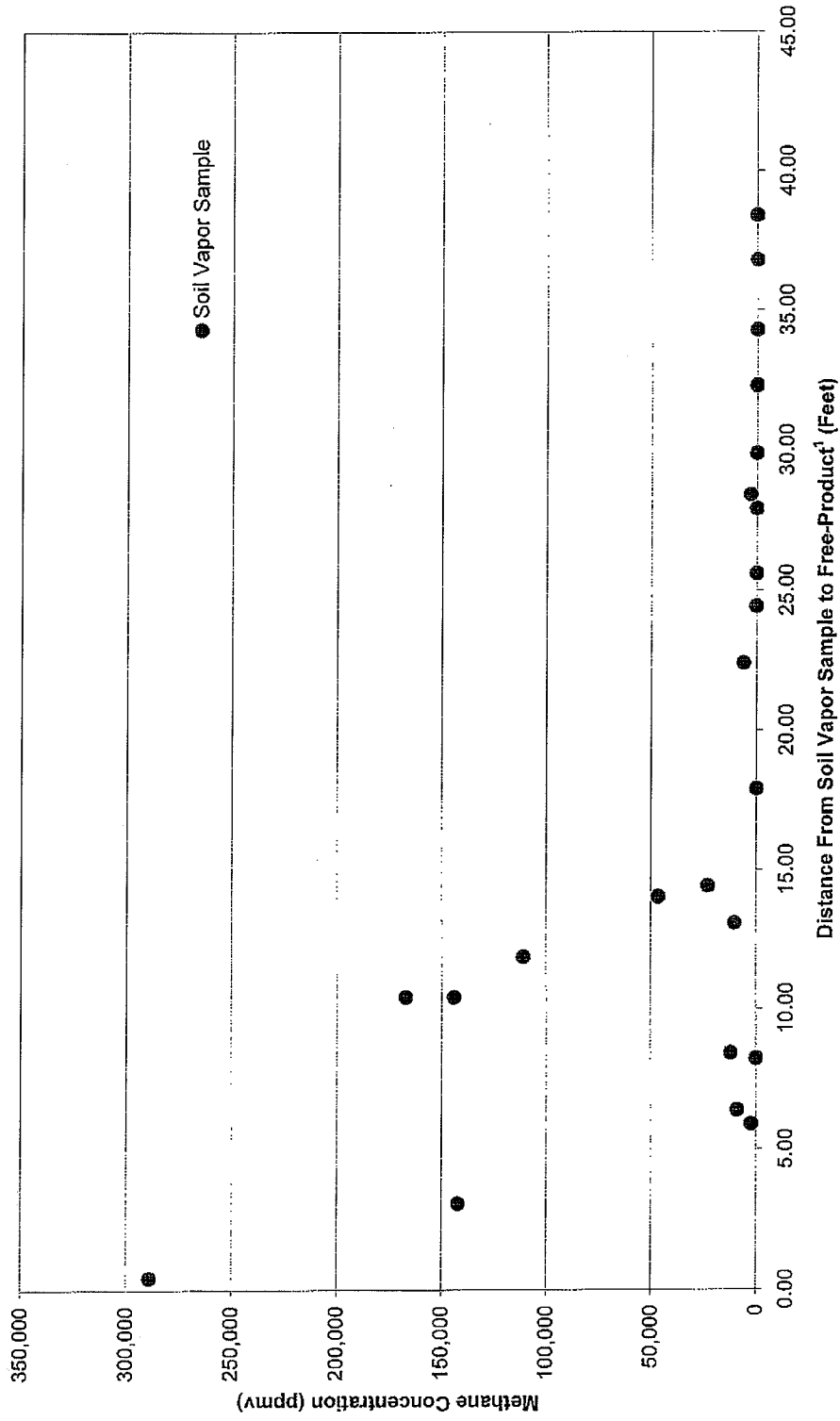


Figure 6. Vadose Zone Attenuation For Methane Concentrations



Note:
ppbv - parts per million by volume

ROUX ASSOCIATES, INC.

MC17230Y16.706/F7

SECTION 02100

VAPOR COLLECTION SYSTEM

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes the following:

1. Installation of building sub-slab methane gas collection system including installation of 4" diameter, HDPE perforated piping, and appurtenances (and those items noted below).
2. Placement of 6" thick, continuous sand blanket layer overlying subgrade and underlying membrane, and surrounding perforated piping.
3. Installation of impermeable membrane, geotextile above and below membrane, membrane attachment batten and associated fittings within building. Includes installation of boots/seals for pipe penetrations through membrane.
4. Installation of 6" thick protective sand layer above membrane.
5. Connection of 4" diameter galvanized riser pipe to 4" diameter perforated, HDPE piping through solid 4" HDPE header piping system. Includes installation of lab cocks for manual measurement of gas (including methane) concentrations, installation of Delphian Methane Determinators (or engineer-approved equivalent), differential pressure transmitters and associated appurtenances (e.g. control panel) at selected locations (see plans), wind turret, and provision for future installation of blowers.
6. Construction of trench dams for utilities penetrating the building from the exterior of the building and for utilities crossing methane vapor collection piping located in parking area.
7. Installation of passive vent system in pavement areas. Includes installation of perforated, HDPE, 4" diameter pipe (or engineer-approved alternates), appurtenances, bedding, and vent risers.

B. Related Documents:

1. The Functional Design Specifications (Attachment 16) within the Contract Documents apply to the work of this Section.
2. Los Angeles Department of Building and Safety, Methane Hazard Mitigation Standard Plan.

C. Related Sections:

1. Section 02300 – Earthwork – Excavation and backfilling of pipe bedding for installation of passive vent system in pavement areas, as well as preparation of subgrade within building.
2. Section 05500 - Metal Fabrications – pipe bollard installation around vent risers located within pavement areas.
3. Section 15150 – Sanitary Waste and Vent Piping – For galvanized vent riser installation and capping.

02100-1 REV1

1.2 DEFINITIONS

- A. HDPE: High Density Polyethylene.
- B. IR: Infrared Methane Determinator.
- C. GRI: Geosynthetic Research Institute.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Pipes and its appurtenances;
 - 2. Pressure sensors;
 - 3. Methane determinators;
 - 4. Monitoring panels and sensor backup battery;
 - 5. Alarm system;
 - 6. Geotextile;
 - 7. HDPE membrane and associated batten attachments;
 - 8. Wind turret;
 - 9. 4-inch ball valves;
 - 10. Manufacturers liquid boot material analysis;
 - 11. Explosion proof fittings for electrical conduit
 - 12. Lab cocks.
- B. Shop drawings.
 - 1. A proposed geomembrane panel plan shall be submitted to and approved by Contracting Officer prior to start of installation procedures.
 - 2. Geomembrane boot details with clamping device, or a sample boot;
 - 3. Wind turret;
 - 4. IR and pressure sensors;
 - 5. All shut-off or other valves;
 - 6. Lab-cock monitoring station protective enclosure;
 - 7. Monitoring panel and sensor backup battery.
- C. Field quality-control inspection and test reports:
 - 1. Sand gradation;
 - 2. Smoke testing;
 - 3. Membrane seaming;
 - 4. Liquid boot installation.

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other marking of specified testing agency.
- B. Impermeable membrane shall be manufactured in accordance with GRI standards.
- C. Impermeable membrane installer shall perform the installation in strict accordance with Terrafix's Quality Control/Installation Manual.

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PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to the manufacturers specified.

2.2 PIPE MATERIALS AND APPURTENANCES

- A. Perforated and Solid HDPE pipes and appurtenances:
1. Pipe: HDPE
 2. Piping shall meet the AASHTO Type S and ASTM D3350 standards, and shall be fusion butt welded or by other means as recommended by the manufacturer (e.g. snap-on connections).
 - i. Pipe shall have a smooth interior and a corrugated exterior.
 - ii. Pipe shall be labeled with manufacturer's name, pipe size and ASTM or AASHTO classification.
 - iii. Pipe shall be installed in accordance with either AASHTO Section 30 or ASTM Recommended Practice D2321.
 - iv. Subject to compliance with project requirements, manufacturers offering products which may be incorporated in the Work, include but are not limited to the following:
 - a. ADS, Inc.
 - b. ISCO Industries.
 - c. ERS, Inc.
 - v. Where perforated pipe is shown on the plans, the total pipe perforation shall be at least equal to 5% of the total surface area of the pipe. Minimum hole size shall be 1/2". Four holes, at 90 degrees, on six inch centers will be drilled in the pipe. To maintain accuracy and uniformity, the pipe is to be drilled by a machine designed for perforating HDPE pipe. No drilling by hand will be allowed. Alternate perforation patterns, meeting the surface area provision, may be approved by Contracting Officer.
 - vi. The fittings shall not reduce or impair the overall integrity or function of the pipeline. Only fittings supplied or recommended by the manufacturer shall be used. Fittings may be either fabricated or molded. Common corrugated fittings include in-line joint fittings, such as couplers and reducers, and branch or complimentary assembly fittings such as tees, wyes, and end caps. These fittings may be installed by various methods such as snap-on, bell and spigot, bell-bell, and wrap around couplers. Couplers shall provide sufficient longitudinal strength to preserve pipe alignment and prevent separation at the joints.
 3. Connection from HDPE to galvanized pipe shall be by Fernco Coupling or other equivalent alternative connection.
 4. A non-woven geotextile "sock" shall be wrapped around the perforated pipes to protect the sand from entering the pipe via the perforations.

02100-3 REV1

B. Galvanized Risers and Fittings: (where indicated on plans)

1. The galvanized riser piping and associated fittings provided for this project shall meet ASTM A888 requirements.
2. Fittings: Fittings required for the galvanized vent pipes, extending through building roof are
 - i. Brass Labcock with Ball Valve (or Flare Valve)
 - ii. Gaskets: ASTM C564
 - iii. Tees, elbows, and couplings
 - iv. Wind turret

2.3 IMPERMEABLE MEMBRANE

A. 60-mil HDPE Membrane: (where indicated on plans)

1. The 60-mil HDPE membrane shall comply with the following standards in terms of its material properties:
 - i. ASTM D1603; ASTM D5596; ASTM D1505; ASTM D1004; ASTM D6693 TYPE IV; ASTM D1599: GRI GM12; ASTM D5397; ASTM D3895; ASTM D5885; and ASTM D5721.
 - ii. Subject to compliance with project requirements, manufacturers offering products which may be incorporated in the Work, include the following:
 1. SOLMAX International.

B. Liquid Boot: (as indicated on plans)

1. All components of liquid boot shall be in accordance with the manufacturer's specifications for "Brownfield Membrane/Liner". (Please see attached Terrafix Quality Control/Installation manual).
2. Liquid Boot shall be used in lieu of 60 mil HDPE membrane in areas of high pipe penetrations as indicated on the plans. Use of Liquid Boot is contingent on temperature conditions per Terrafix Quality Control/Installation Manual. Minimum require thickness of liquid boot is 80 mil.

2.4 MEMBRANE ATTACHMENT BATTEN (please refer to attached installer's (i.e. Terrafix) Quality Control/Installation Manual)

- A. Anchor Pins
- B. Self-tapping screws
- C. Neoprene Gasket – ¼" x 2"
- D. Polyurethane Sealant
- E. ¼" x 2" HDPE Batten Bar

2.5 GEOTEXTILE

- A. 12 oz. and 6 oz. Nonwoven Geotextile shall be used above and below the 60-mil HDPE membrane respectively, with compliance to the following standards:
 1. ASTM D5261; ASTM D4632; ASTM D4533; ASTM D4833; ASTM D3786; ASTM D4491; ASTM D4751; and ASTM D4355.

02100-4 REV1

2. Subject to compliance with project requirements, manufacturers offering products which may be incorporated in the Work, include the following:
 - i. SKAPS Industries.

2.6 SAND

- A. Sand Layer Above Membrane: 6-inches MDOT Class II sand cushion shall be provided above the membrane, conforming to the following gradation:

| Sieve Size | Total Percent Passing |
|------------|-----------------------|
| 1" | 60-100 |
| No.100 | 0-30 |
| No.200 | 0-5 |

- B. Sand Blanket for Vapor Extraction Pipes: 6-inches MDOT Class II sand layer shall be installed acting as a blanket for the vapor extraction pipes below the membrane. The gradation of sand shall be as specified above.

2.7 METHANE DETERMINATORS AND PRESSURE SENSORS

- A. Infrared CHC Determinator Gas Monitoring System, manufactured by Delphian, Model 850, or equivalent. Install Determinators in four vent risers and two stubs as indicated on plans, as per manufacturer's recommendations. Refer to plans for location of the determinators. Four (4) Methane Determinators (and optional 12 determinators, as per owner's request) shall be installed in the building (in enclosed or semi enclosed spaces, such as closets, storage, alcoves, etc.) where there is lack of ventilation, as indicated on plans. The wiring of the determinator shall be connected through a flex conduit. Methane Determinators shall be automated and connected to the central on-site monitoring system that is setup to be monitored off-site, 24 hours a day, 7 days per week, for alarm conditions.
- B. Dwyer series 608 Differential Pressure Transmitter or equivalent shall be installed in four vent risers. The installation process shall be as per manufacturer's recommendations. Pressure sensors shall be automated and connected to the central on-site monitoring system that is setup to be monitored off-site, 24 hours a day, 7 days per week, for alarm conditions.
- C. All methane determinators shall be connected to the SAGE CE system incorporating Silent Knight SK-5208 Control Panel, dedicated 120 VAC Line, Delphian I.R. Interface Module, Sensor Satellites 485, Relay Satellites 485 and SAGE-CE Touch Screen. The system will be programmed to activate the blowers on the prescribed %LEL. It will also include chimes/horns and strobes to notify the designated personnel of the alarm conditions.
- D. Closet space enclosing the vent riser, shall be as designed by the architect.

2.8 TRENCH DAMS

- A. Trench dams may be constructed of any of the following materials:

02100-5 REV1

1. Bentonite Cement Slurry mix, 3 feet long, shall be applied along the utility trench penetrating through the building. The mixture shall contain, 4% Type II Cement and 2% Powdered Bentonite.
2. Native clay soils backfill (or clay plug) compacted to at least 95% relative compaction in accordance with ASTM D1577 at a minimum length of 5 feet.
3. Concrete mixes other than Bentonite cement slurry may be used provided conduit or piping is wrapped with High Density HDPE foam tape (closed cells, Adhesive Blacked, ¼” thick by ½” wide) shall be applied to clear surface with ends butted together at most visible locations in trench dam.

2.9 VENT RISER

- A. A 4-inch galvanized riser shall be connected to the horizontal perforated pipes, to facilitate venting of gases. The vent riser shall have a minimum size of 4 inches in diameter and a minimum above ground height of ten (10) feet. The vent risers in the pavement area shall be protected by installing 3 pipe bollards around them.
- B. The concrete mix used in vent riser foundation shall have a minimum strength of 3,000 psi.

2.10 GRAVEL BACKFILL FOR PARKING LOT TRENCHES

- A. MDOT 6A gravel bedding/backfill, conforming to the following gradation shall be provided for parking lot trenches:

| Sieve Size | Total Percent Passing |
|------------|-----------------------|
| 1-1/2” | 100 |
| 1” | 95-100 |
| ½” | 30-60 |
| No.4 | 0-8 |
| No.200 | 0-5 |

ART 3 – EXECUTION

3.1 SUBGRADE

- A. The subgrade shall be compacted as specified in section 02300, and a smooth surface shall be prepared for the placement of the sand layer.

3.2 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 15 Section “Basic Mechanical Materials and Methods” of the Contract Documents.
- B. Installation of HDPE piping shall be in accordance with local (e.g. Pontiac) plumbing codes.
- C. Installation of galvanized risers shall be in accordance with BOCA National Mechanical Code, 1990, Article 8 “Gas Piping Systems” or local code, whichever is more stringent.

02100-6 REV1

- D. Provide membrane boot for pipe penetrations through the impermeable membrane in accordance with manufacturer's recommendations.
- E. Inspect interior of piping to determine whether line displacement or other damage has occurred. Defects requiring correction include the following:
 - 1. Alignment; Deflection; crushed, broke, cracked, or otherwise damaged piping; infiltration.
 - 2. Replace defective piping using new materials and repeat inspection until results are satisfactory.
 - 3. Fusion welded HDPE pipe shall be Air Tested in accordance with ASTM F1417, "Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air".

3.3 SAND BLANKET FOR PERFORATED AND SOLID PIPES

- A. 6 inches of sand shall be placed on the prepared subgrade and surrounding the perforated piping. Care shall be taken not to disturb the alignment or location of the pipes during sand placement. An as-built survey shall be performed to verify the elevations and locations of the methane collection perforated and solid header piping.

3.4 MEMBRANE AND GEOTEXTILE INSTALLATION

- A. HDPE membrane, geotextiles, liquid boot, and membrane boot shall be installed as per manufacturer's recommendations (please see attached Terrafix Quality Control/Installation Manual for detailed installation instructions). High pressure or hot equipment shall be avoided on the membrane/geotextiles to prevent damage.

3.5 SAND LAYER ABOVE GEOMEMBRANE/GEOTEXTILE

- A. 6-inches sand layer shall be placed uniformly on the geomembrane/geotextile. Only nominal compaction needs to be applied to the sand layer. Over-compaction due to equipment traffic must be avoided.
- B. Care must be taken to prevent any possibility of damage to the geosynthetics during sand blanket placement. Wrinkles noted in the geosynthetics during sand layer placement should be relaxed and corrected in accordance with the installer's recommendations.
- C. A minimum thickness of one (1) foot of sand shall be maintained between a light-tracked vehicle and the membrane to prevent damage to the liner (i.e. sand shall be placed by casting it outward from areas where the sand thickness has been increased above one foot).
- D. Sand shall be placed in such a manner as to avoid overburden stresses on the methane collection piping from equipment operations (e.g. casting of sand with bulldozer).

02100-7 REV1

3.6 METHANE DETERMINATORS AND DIFFERENTIAL PRESSURE TRANSMITTERS

- A. Methane determinators and differential pressure transducers shall be installed in the galvanized vent risers with appropriate pipe fittings. The wiring of the remediator shall be extended along a flexible conduit and connected to the central on-site monitoring system, through a flex conduit. The location of the control panel shall be located in a secure location within the building as designated by the owner. Detailed installation of these devices shall be in accordance with manufacturer's recommendations (Delphian and Dwyer).

3.7 LABCOCKS

- A. Labcocks/Flare valves shall be installed in all galvanized vent risers, to facilitate frequent manual monitoring of methane and/or pressure. The labcock shall be equipped with a ball valve, and shall be installed as per manufacturer's recommendations.

3.8 PARKING LOT METHANE GAS VENT TRENCH

- A. Trench Construction and Placement of Pipes
 - 1. The horizontal perforated pipe shall be centrally placed in a 12-inch wide by 12-inch deep trench and backfilled with MDOT 6A Aggregate.
- B. Vent Risers
 - 1. A 4-inch galvanized pipe shall be installed at vent riser locations, as shown on plans. The pipes shall act as vent risers and shall be connected to the horizontal perforated pipes.
 - 2. The height of the vent riser shall be a minimum of ten (10) feet, and the minimum dimensions of the foundation shall be as indicated on the drawings.
 - 3. The top cap of the pipe shall be such that venting of the gases is made possible with prevention of rain, snow into the pipe.

3.9 TRENCH DAM/UTILITY TRENCH PLUG CONSTRUCTION

- A. Trench dams shall be installed in all methane collection trenches at the point where the trench crosses the boundary of the LNAPL plume or at the end of the trench when the entire trench is outside the LNAPL plume area. Utility trench plugs shall be placed where conduit penetrates the building footprint below the geomembrane liner.
- B. The length of the trench dam shall be twice the width of the trench, but no less than three (3) feet.
- C. Trench dams shall be constructed of one of the following:
 - 1. Bentonite Cement Slurry mixture of 4% Type II Cement and 2% Powdered Bentonite.
 - 2. Compacted Native Cohesive Soils Backfill, compacted at least 90% relative compaction in accordance with ASTM D-1557.
 - 3. Concrete mixes other than Bentonite Cement Slurry may be used provided conduit or piping is wrapped with High Density PVC Foam Tape, Closed Cells, Adhesive Backed, 1/4" thick by 1/2" wide, applied to clear surface with ends butted together at locations in trench dam.

02100-8 REV1

3.10 CONCRETE BOLLARDS

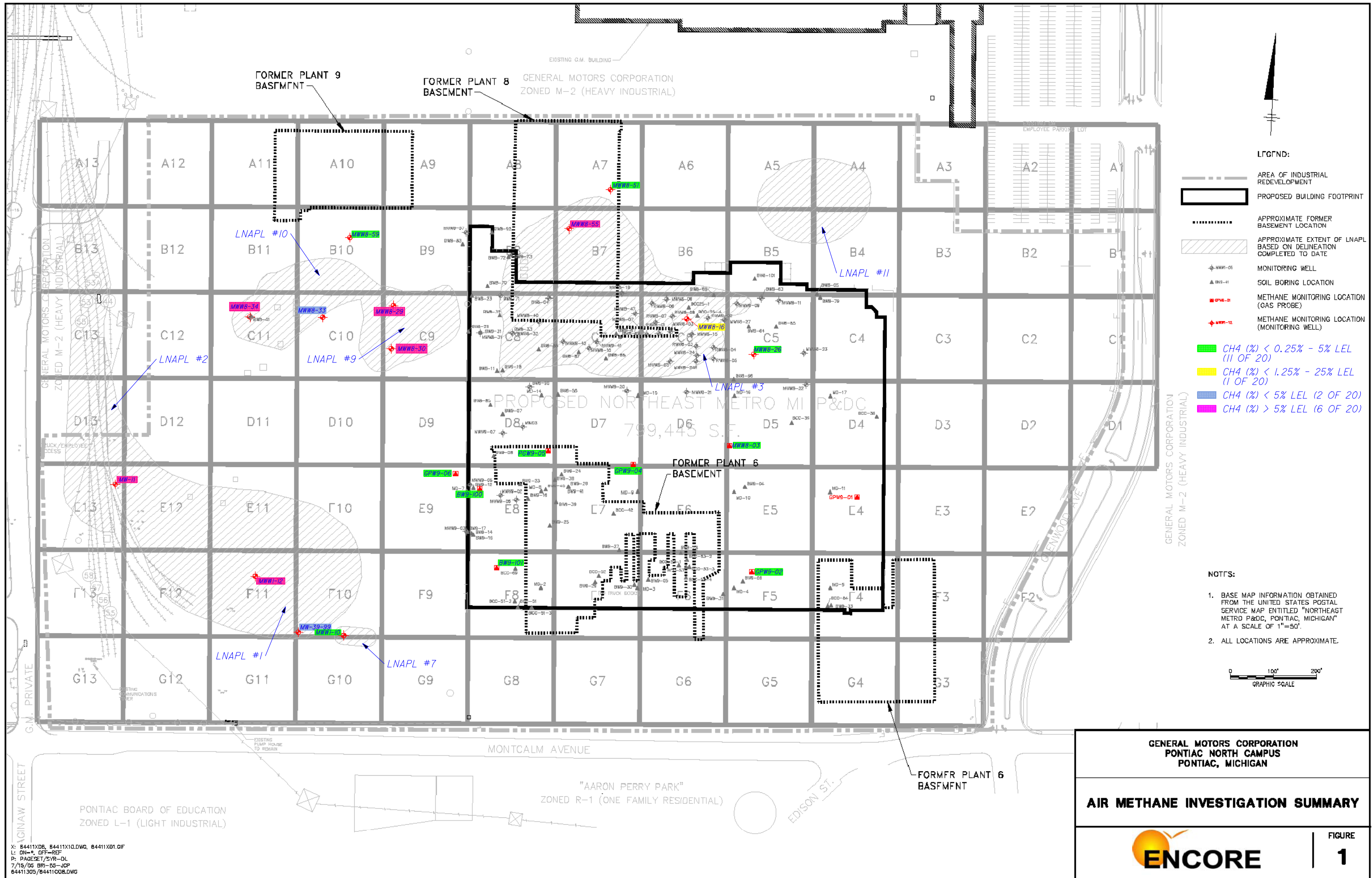
- A. Three (3) pipe bollards shall be installed in accordance with Section 05500 in the pavement area, as protective barriers around the vent risers.

3.11 FIELD QUALITY CONTROL

- A. The subgrade shall be inspected for proper grading, elevation, excess moisture and loose material, before placement of the sand layer.
- B. Sand thicknesses for the sand blanket and membrane protective layers shall be verified to confirm a minimum of 6-inches of sand in the entire building pad, both prior to membrane placement and a second 6-inch sand layer overlying the 12 oz. geotextile protecting the membrane.
- C. Placement and location of pipes shall be verified for required location and elevations.
- D. Clear interior of piping and structures of dirt and superfluous material as the work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and whenever work stops.
- F. Appropriate membrane and geotextile installation shall be verified in accordance with Terrafix's Quality Control/Installation Manual.
- G. The protective sand layer above the membrane shall be continuously inspected to prevent excessive vehicular traffic on it.
- H. Verify impermeability of geomembrane through smoke testing and/or seam testing.

END OF SECTION

02100-9 REV1



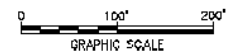
LEGEND:

- AREA OF INDUSTRIAL REDEVELOPMENT
- ▭ PROPOSED BUILDING FOOTPRINT
- ⋯ APPROXIMATE FORMER BASEMENT LOCATION
- ▨ APPROXIMATE EXTENT OF LNAPL BASED ON DELINEATION COMPLETED TO DATE
- ⊕ MW-05 MONITORING WELL
- ▲ SW-41 SOIL BORING LOCATION
- GP-03 METHANE MONITORING LOCATION (GAS PROBE)
- ◆ MWB-12 METHANE MONITORING LOCATION (MONITORING WELL)

- CH₄ (%) < 0.25% - 5% LEL (11 OF 20)
- CH₄ (%) < 1.25% - 25% LEL (1 OF 20)
- CH₄ (%) < 5% LEL (2 OF 20)
- CH₄ (%) > 5% LEL (6 OF 20)

NOTES:

1. BASE MAP INFORMATION OBTAINED FROM THE UNITED STATES POSTAL SERVICE MAP ENTITLED "NORTHEAST METRO P&DC, PONTIAC, MICHIGAN" AT A SCALE OF 1"=50'.
2. ALL LOCATIONS ARE APPROXIMATE.



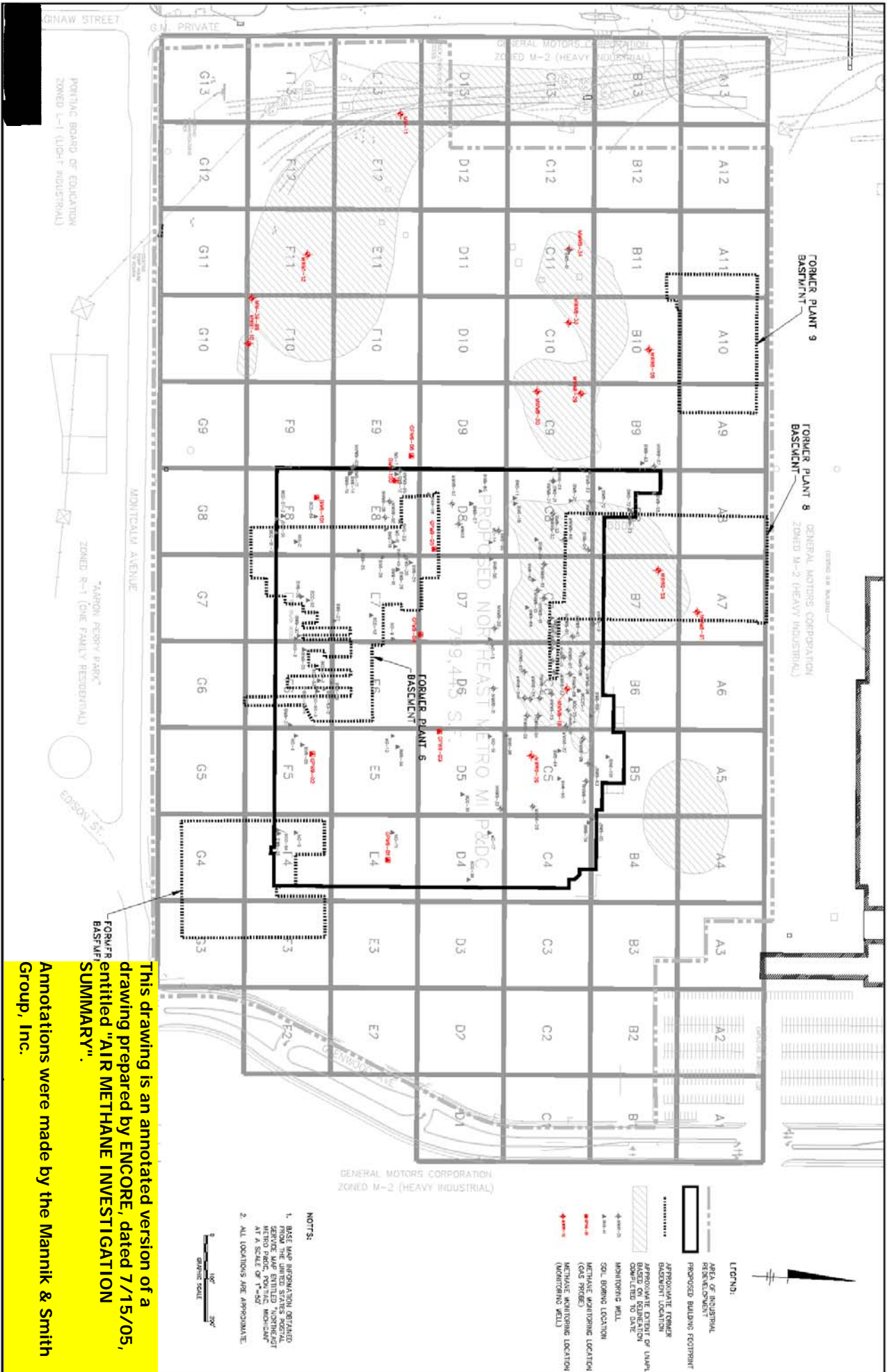
**GENERAL MOTORS CORPORATION
PONTIAC NORTH CAMPUS
PONTIAC, MICHIGAN**

AIR METHANE INVESTIGATION SUMMARY

ENCORE

FIGURE
1

X: 84411X08, 84411X10.DWG, 84411X01.CIF
 L: DN-*, OFF-REF
 P: PAGESET/SYR-DL
 7/15/05 BRI-BG-JCP
 84411305/84411008.DWG

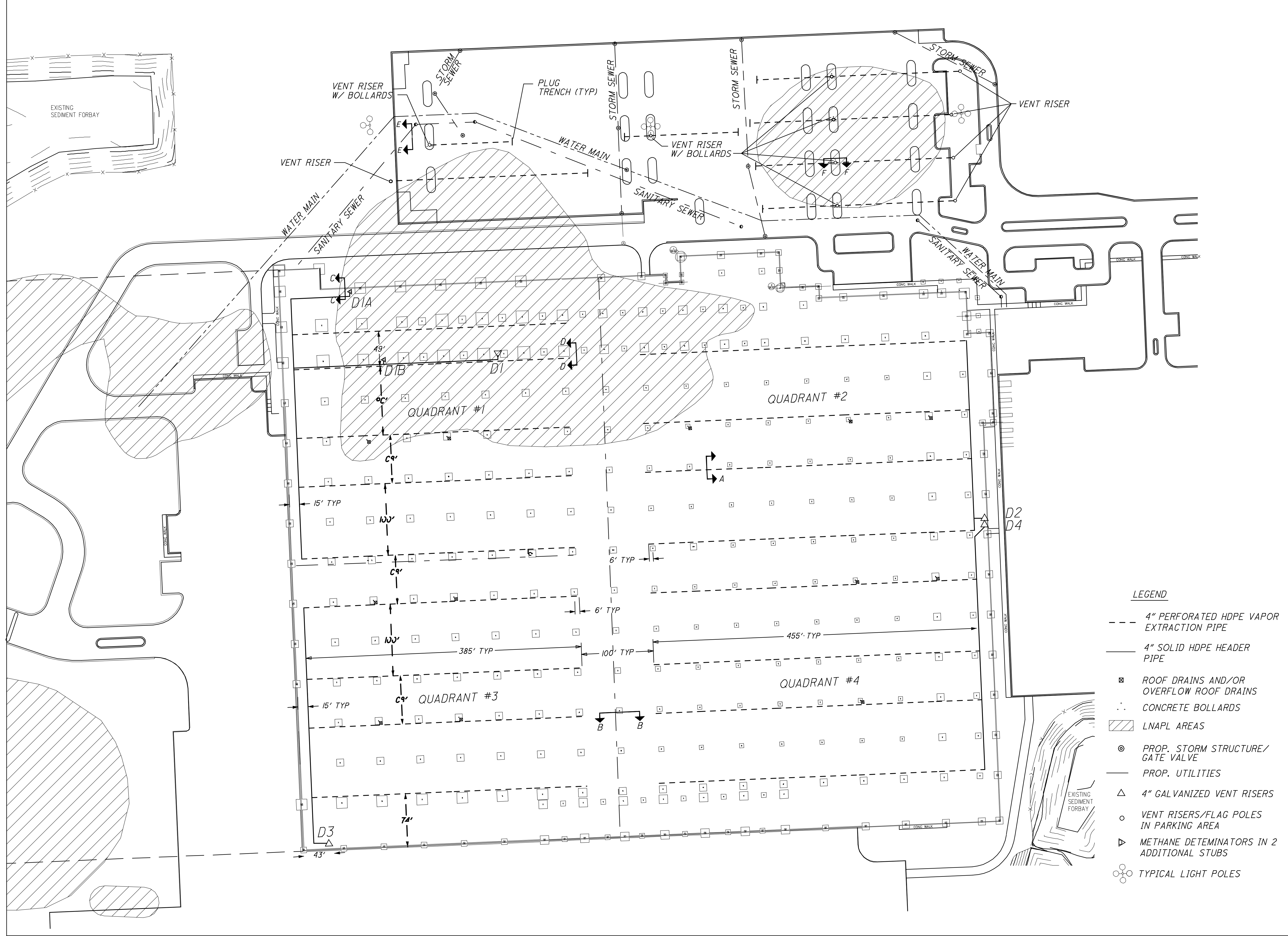


This drawing is an annotated version of a drawing prepared by ENCORE, dated 7/15/05, entitled "AIR METHANE INVESTIGATION SUMMARY". Annotations were made by the Mannik & Smith Group, Inc.

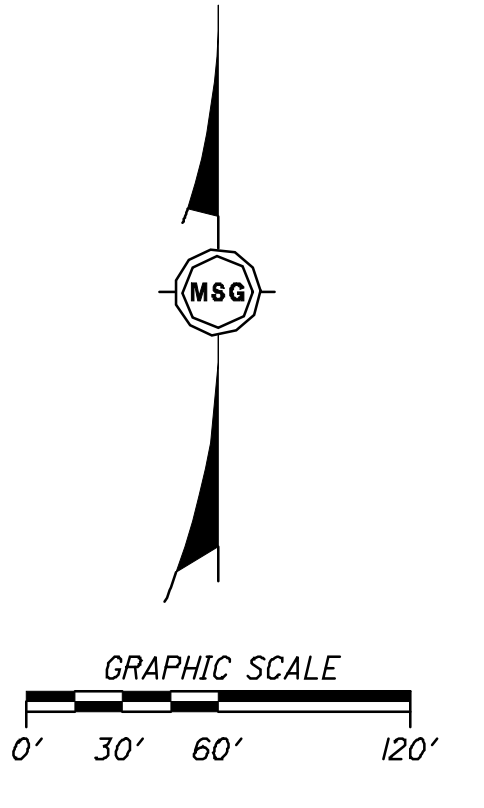
- NOTES:
1. BASE MAP INFORMATION OBTAINED FROM THE UNITED STATES NATIONAL BUREAU OF GEOLOGICAL SURVEY METRO PARK, PORTLAND, MICHIGAN AT A SCALE OF 1"=50'
 2. ALL LOCATIONS ARE APPROXIMATE.



- LEGEND:
- AREA OF INDUSTRIAL REDEVELOPMENT
 - PROPOSED BUILDING FOOTPRINT
 - APPROXIMATE FORMER BASEMENT LOCATION
 - APPROXIMATE EXTENT OF LAND COMPLETED TO DATE
 - MONITORING WELL
 - SOL BIRING LOCATION
 - METHANE MONITORING LOCATION (GAS PROBE)
 - METHANE MONITORING LOCATION (MONITORING WELL)



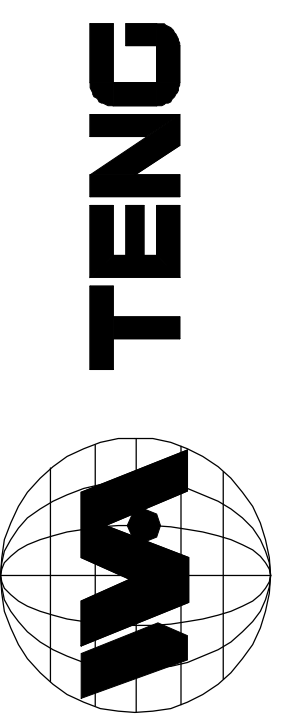
- LEGEND**
- 4" PERFORATED HDPE VAPOR EXTRACTION PIPE
 - 4" SOLID HDPE HEADER PIPE
 - ⊠ ROOF DRAINS AND/OR OVERFLOW ROOF DRAINS
 - ⋯ CONCRETE BOLLARDS
 - ▨ LNAPL AREAS
 - ⊙ PROP. STORM STRUCTURE/ GATE VALVE
 - PROP. UTILITIES
 - △ 4" GALVANIZED VENT RISERS
 - VENT RISERS/FLAG POLES IN PARKING AREA
 - ▶ METHANE DETEMINATORS IN 2 ADDITIONAL STUBS
 - ⊗ TYPICAL LIGHT POLES



SVE-01 PROPOSED VAPOR EXTRACTION SYSTEM
 Scale: Project: 21 4671 01 Date: JANUARY 12, 2007 Revisions:
 USFS File Number: 982441



NORTHEAST METRO
 MICHIGAN P AND DC
 2711 NORTH GLENWOOD AVENUE
 PONTIAC, MI 48240-9991

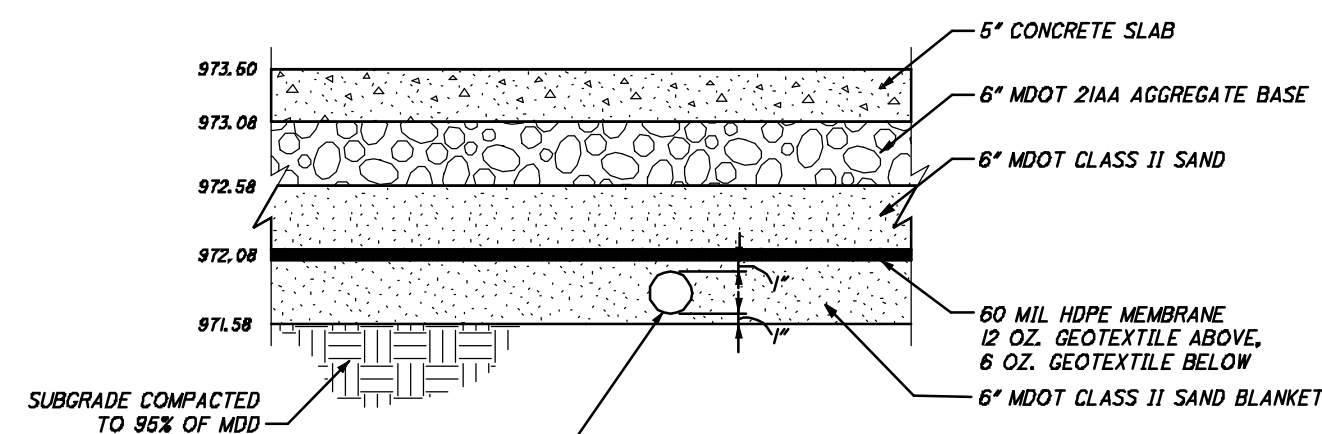


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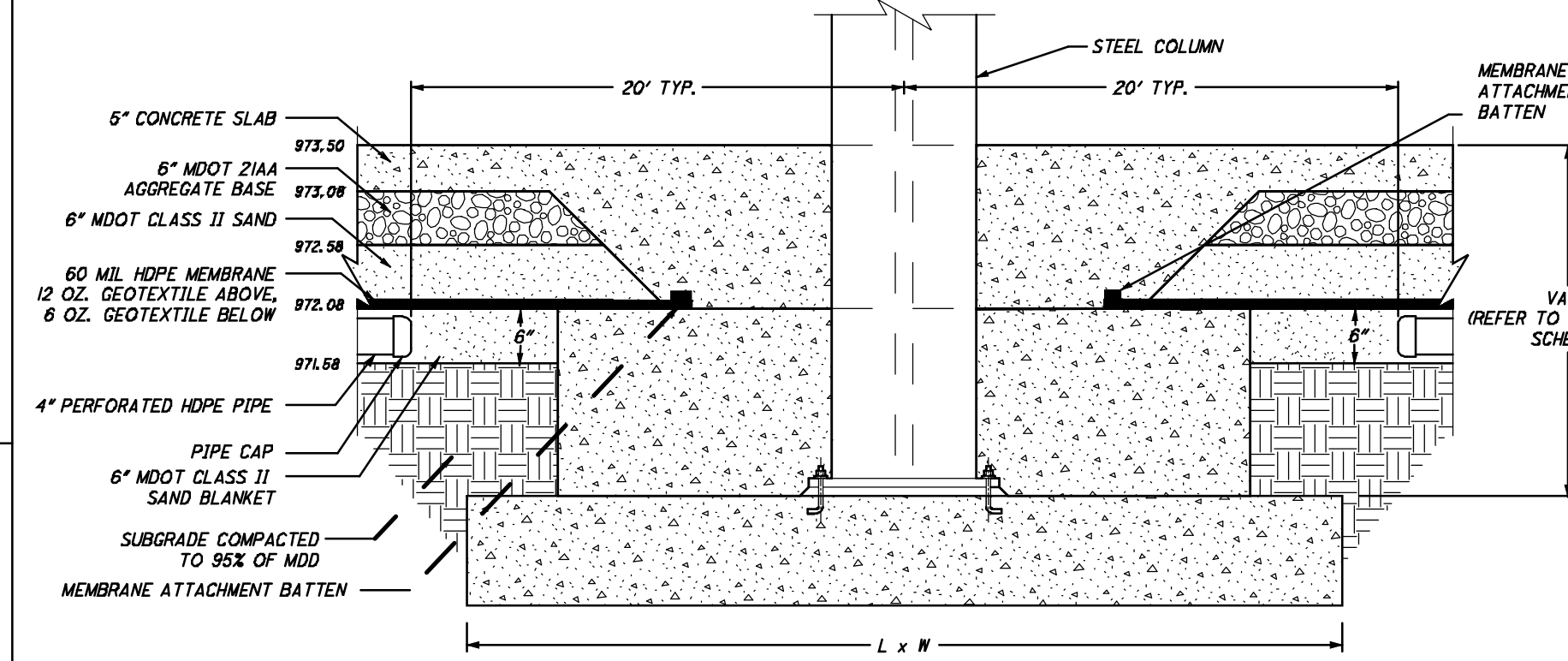
CAUTION: DO NOT SCALE DRAWINGS.
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ISSUED FOR CONSTRUCTION - 01.12.07

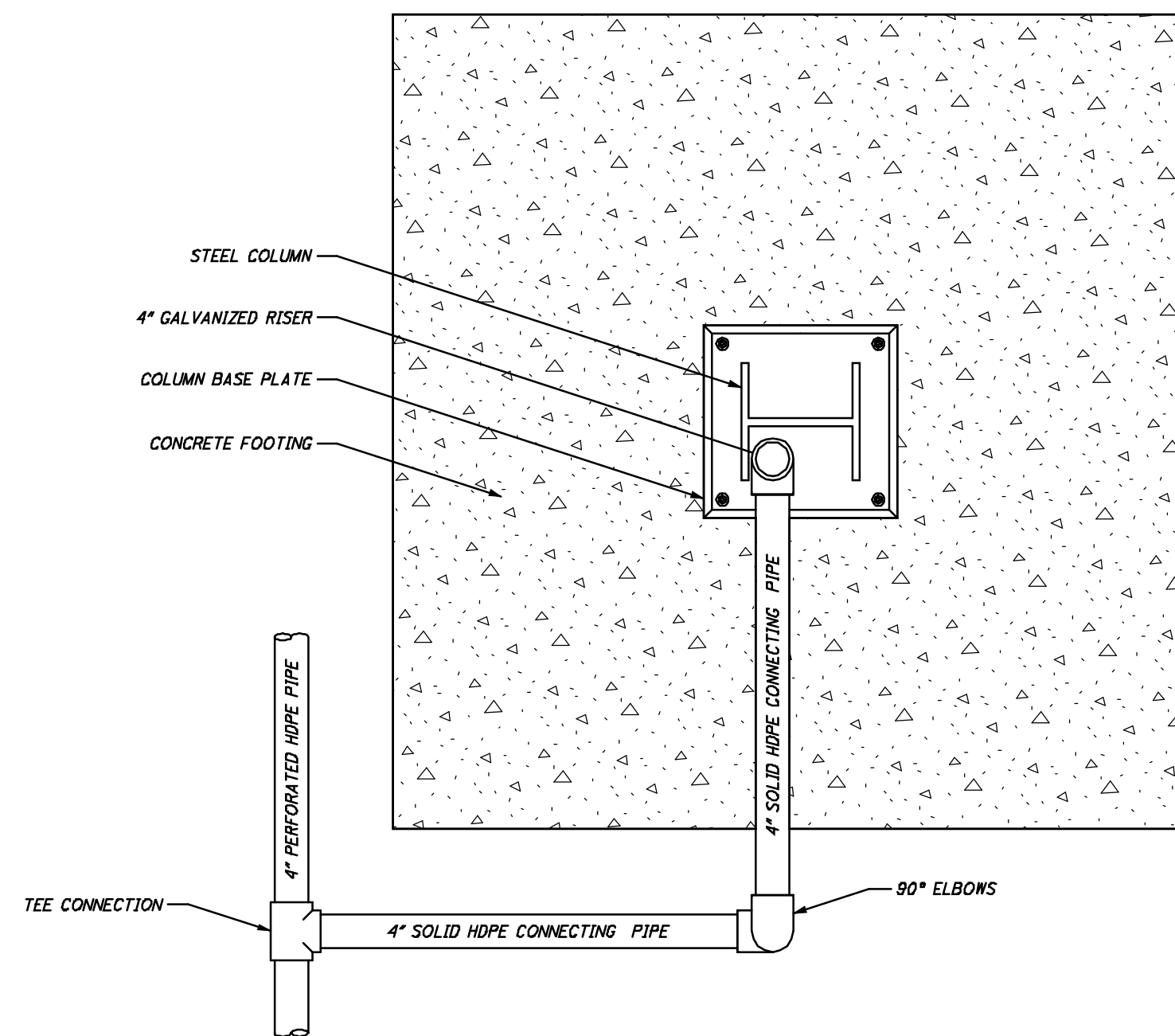
4301 WILSON BLVD., SUITE 300 ARLINGTON, VA 22203-1861



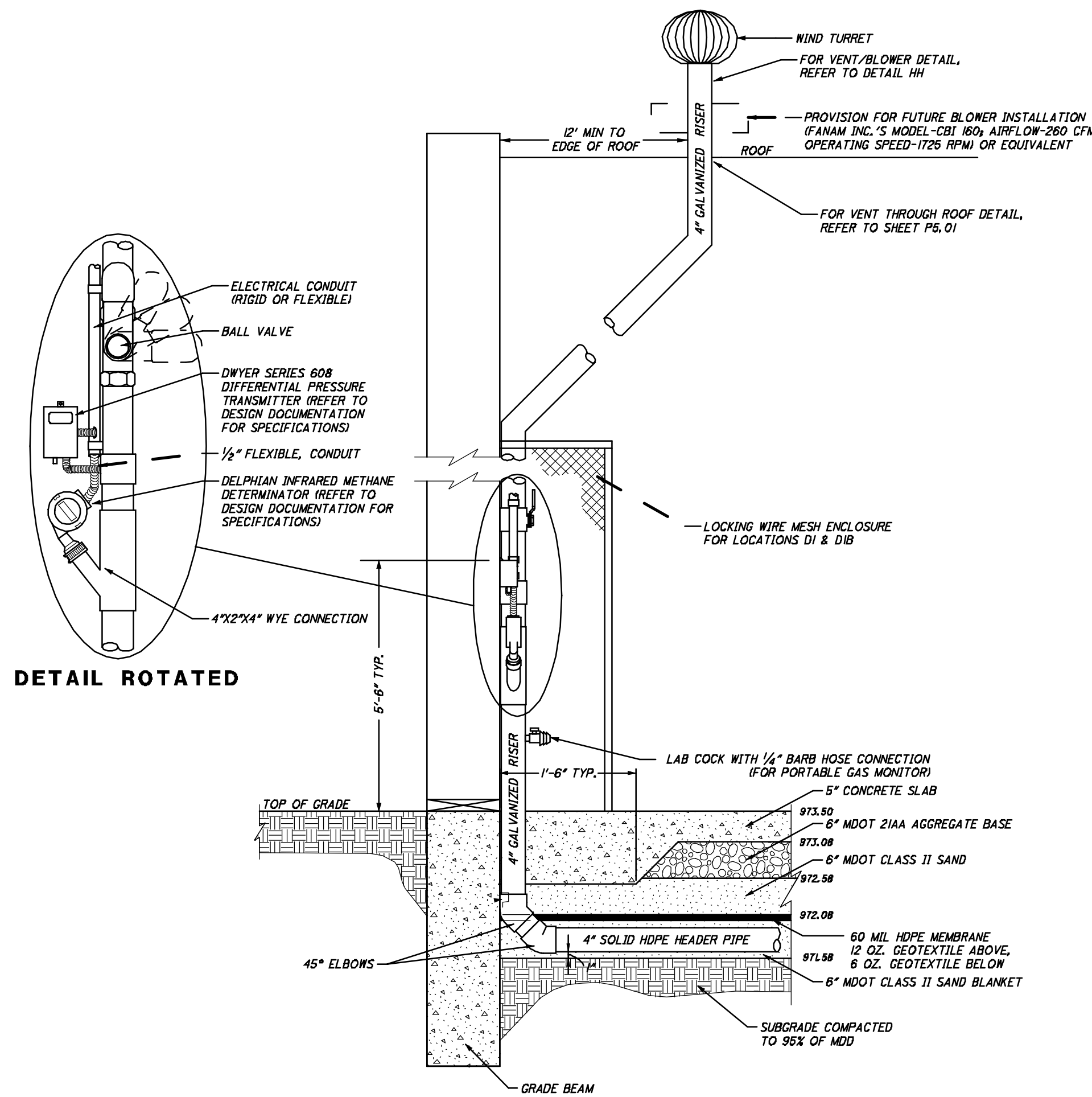
TYPICAL SVE DETAIL UNDER FLOOR SLAB AA
SVE 01
N.T.S.



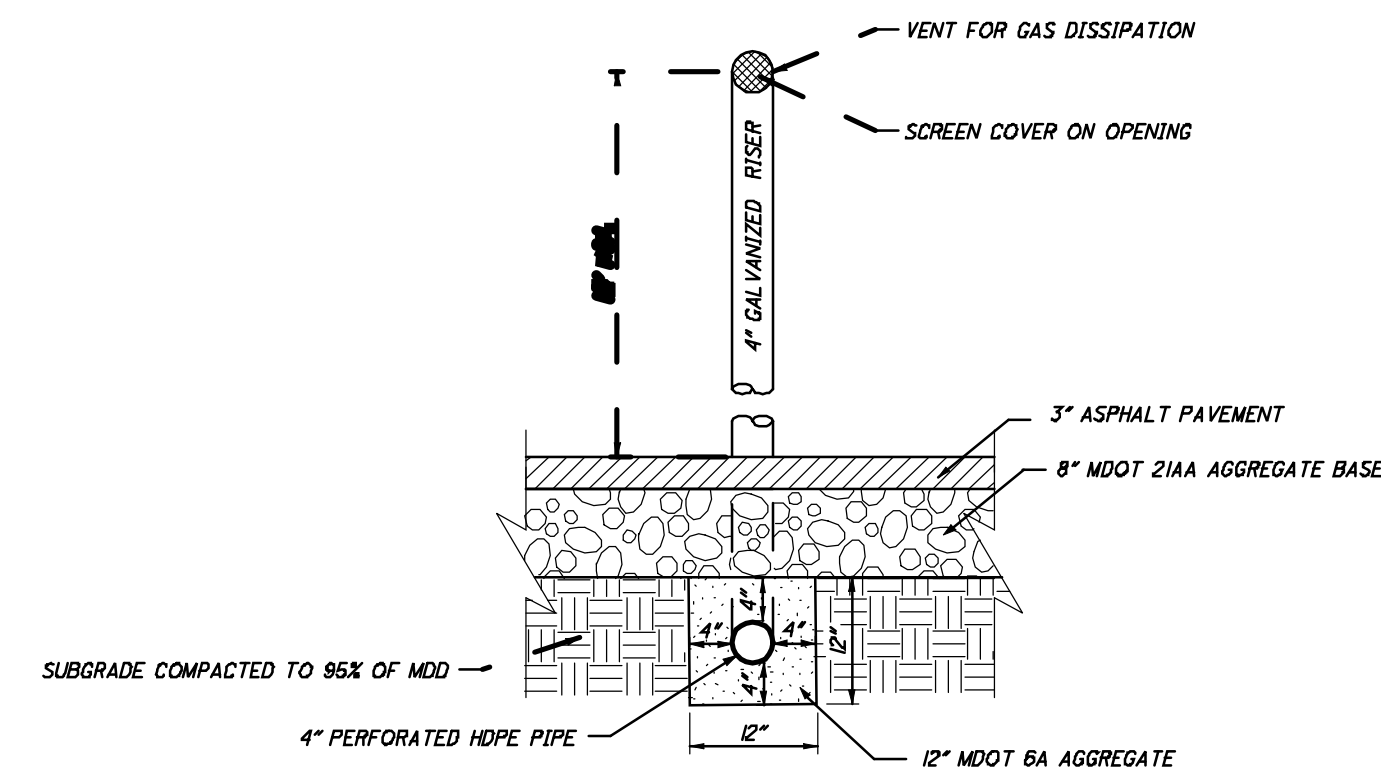
PERFORATED PIPE TERMINATION AT THE CENTER OF THE BUILDING BB
SVE 01
N.T.S.



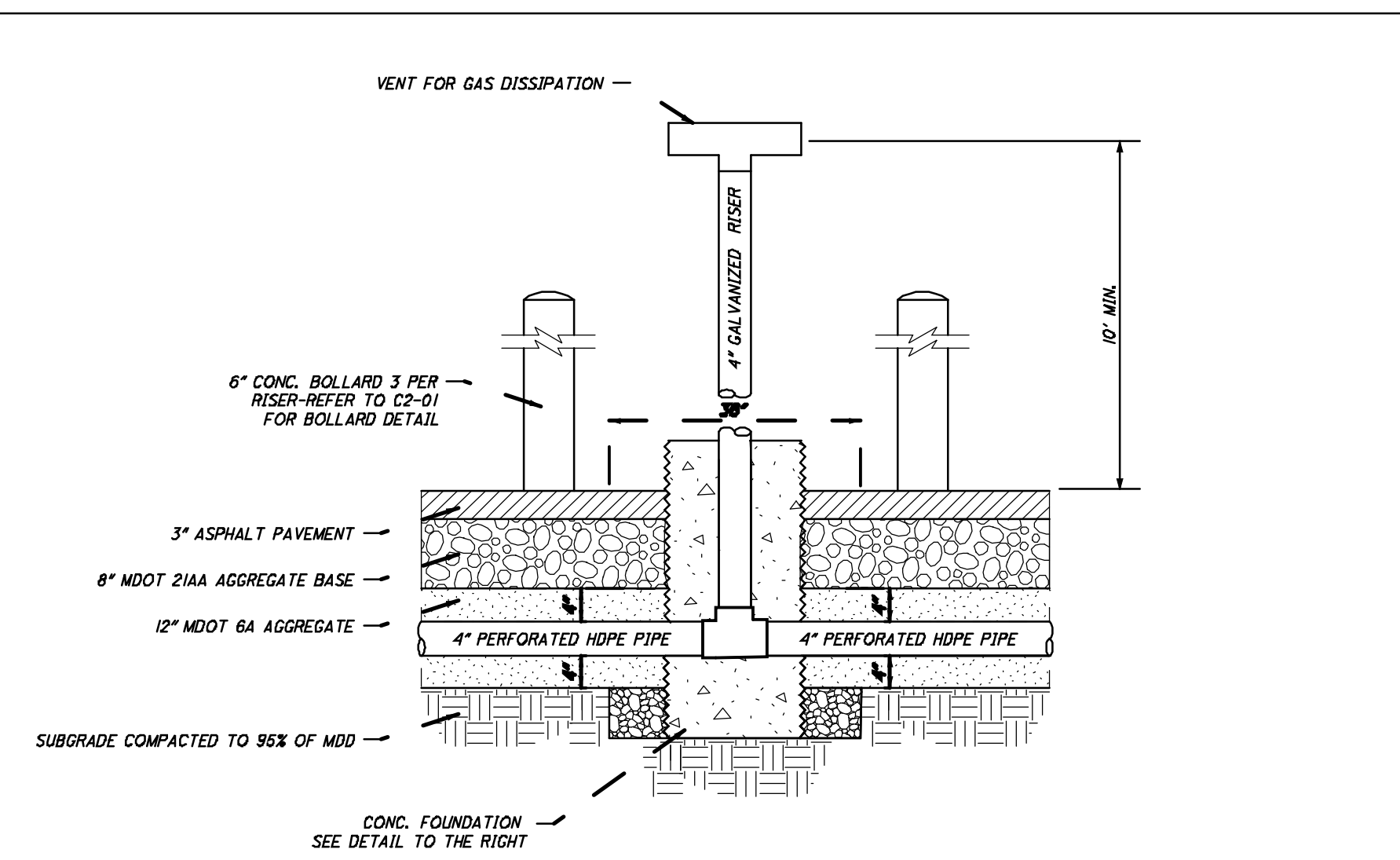
METHANE DETERMINATORS AT 4 ADDITIONAL LOCATIONS DD
SVE 01
N.T.S.



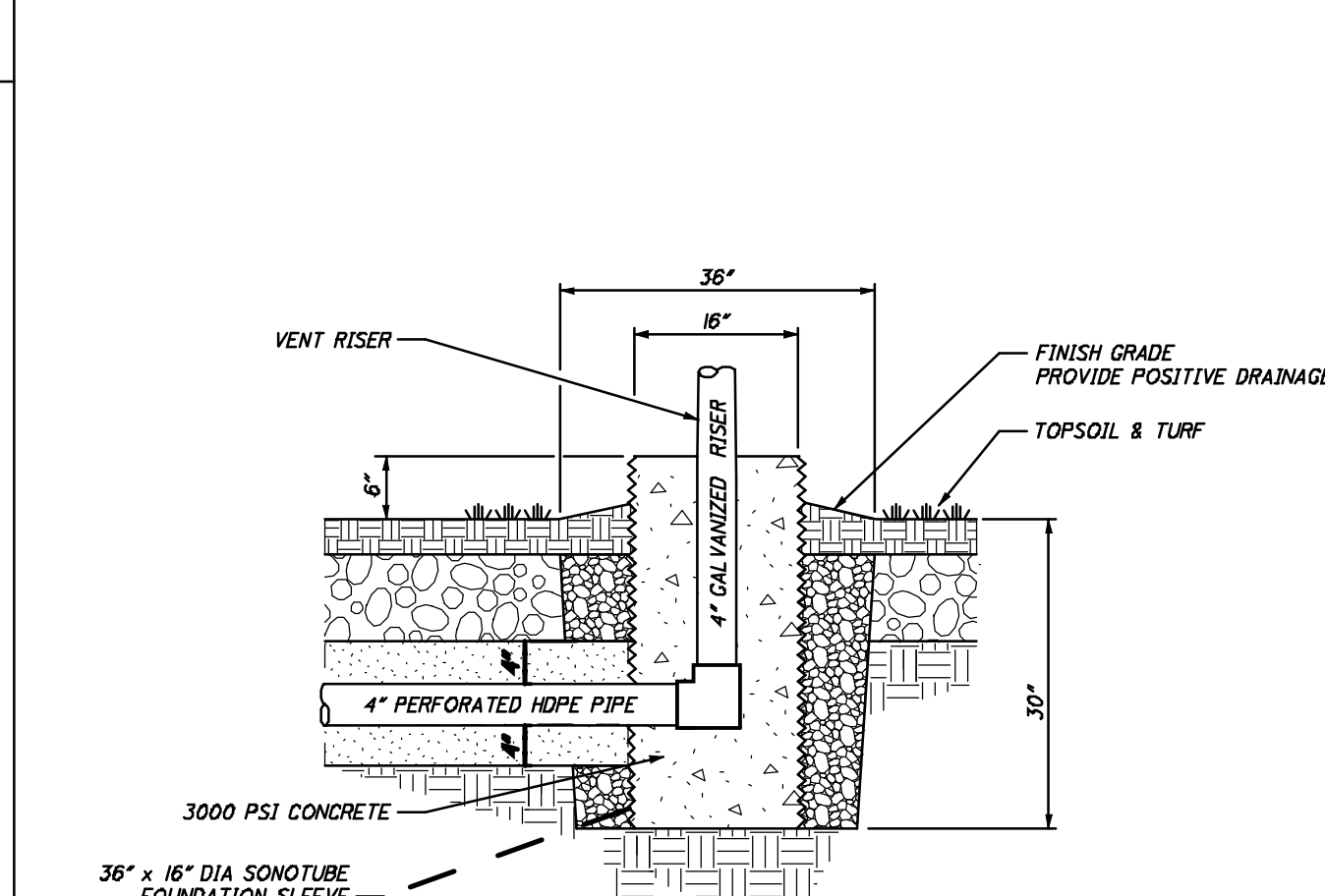
HEADER PIPE CONNECTION TO VENT RISER WITH METHANE/PRESSURE SENSORS AND PROVISION FOR BLOWER CC
SVE 01
N.T.S.



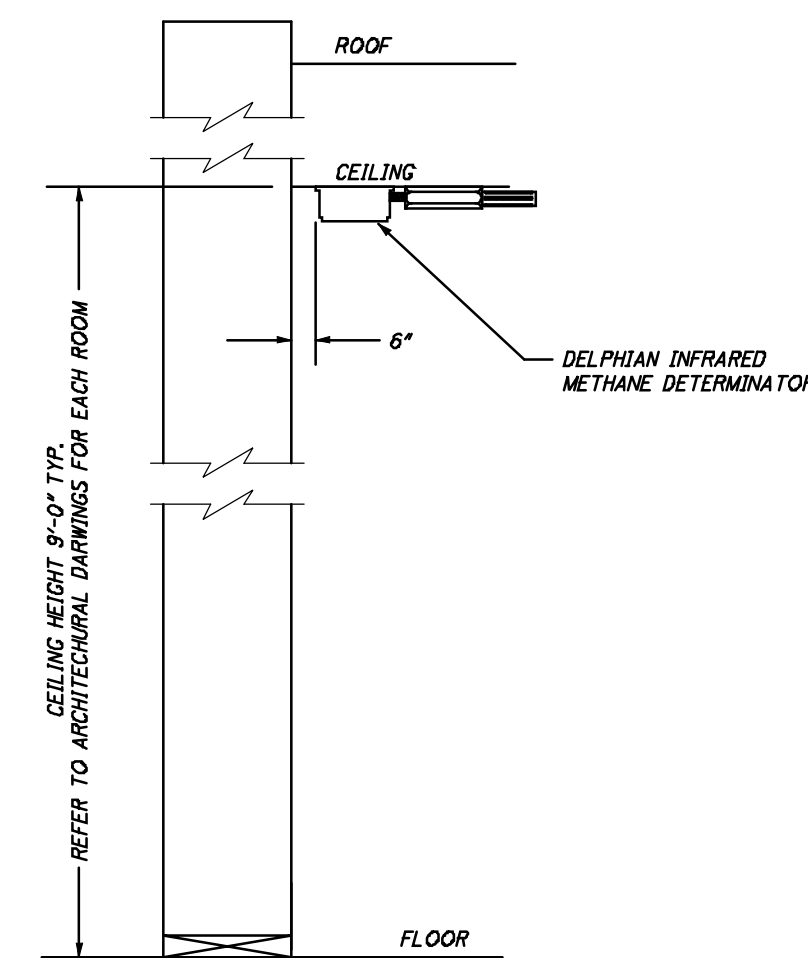
PASSIVE SVE SYSTEM IN PARKING AREA EE
SVE 01
N.T.S.



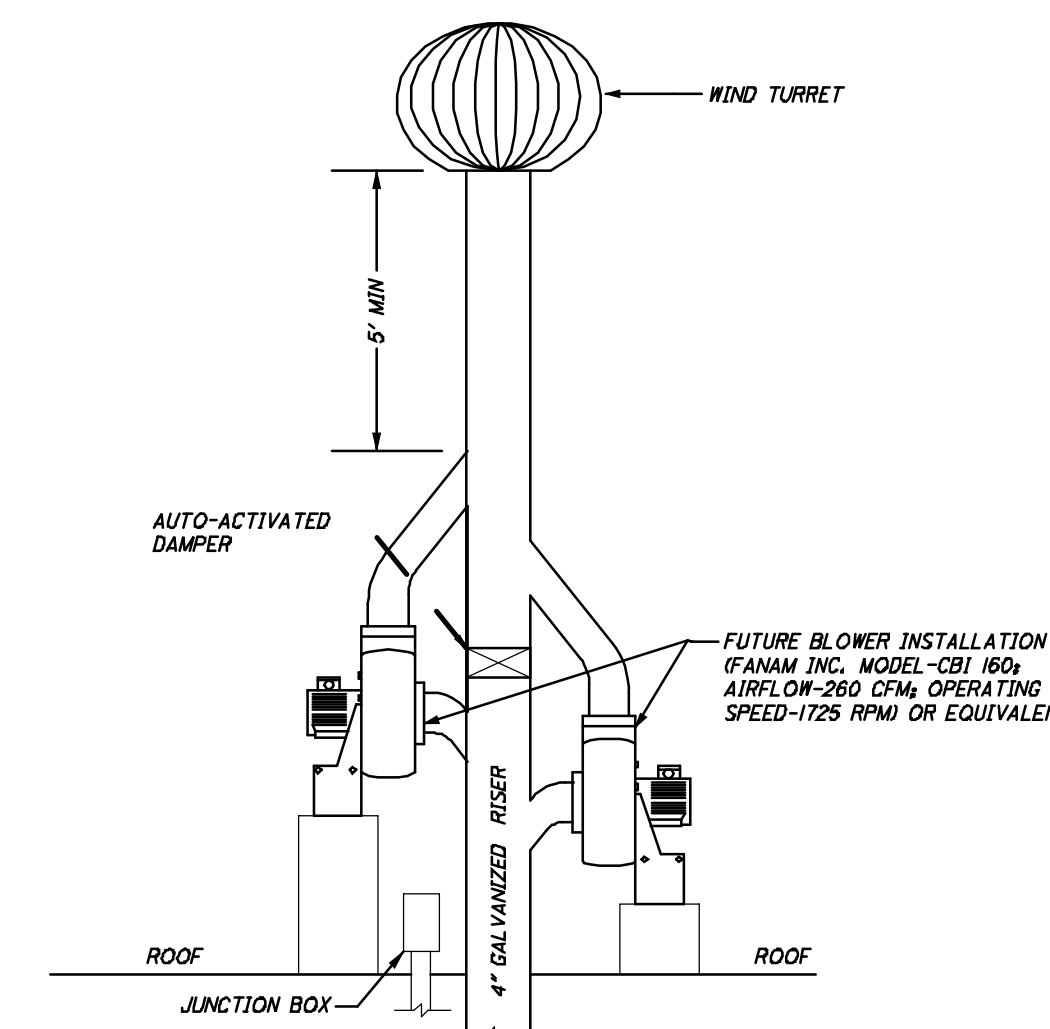
PARKING AREA VENT RISER DETAIL FF
SVE 01
N.T.S.



TYP. FOUNDATION TT
N.T.S.



INFRARED METHANE DETERMINATORS GG
SVE 01
N.T.S.



FUTURE BLOWER CONNECTION HH
SVE 01
N.T.S.

NOTE:
PLEASE REFER TO SVE 04 FOR MEMBRANE TERMINATION, MEMBRANE BOOT AND MEMBRANE ATTACHMENT BATTEN DETAILS

