PERFORMANCE MONITORING PLAN

SHEET PILE BARRIER ALONG GREAT MIAMI RIVER

CHEVRON CINCINNATI FACILITY

HOOVEN, OHIO

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1.0 BARRIER PERFORMANCE AND ENVIRONMENTAL MONITORING

This Performance Monitoring Plan has been prepared to fulfill the requirements of Section VI.12.a. of the Administrative Order on Consent (Docket RCRA-05-2007-001) that was agreed to between Chevron U.S.A, Inc. (Chevron) and Region 5 of the United States Environmental Protection Agency (U.S. EPA) on November 1, 2006. The plan included herein specifies the requirements for operation, maintenance, and monitoring of components related to the stabilization of the west bank of the Great Miami River and shall be incorporated into the *Operation, Monitoring, and Maintenance (OMM) Plan for the Final Groundwater Remedy* (Chevron 2007b) by reference following U.S. EPA approval of the *Remedial Measures Work Plan for Sheet Pile Barrier and Bank Stabilization along the Great Miami River* (Chevron 2007c).

The stabilization of the west bank comprises one component of the final groundwater remedy to address light nonaqueous phase liquids (LNAPL) and dissolved phase impacts associated with historical refining activities performed at the Chevron Cincinnati Facility. Through the course of assessment activities conducted along the west bank of the Great Miami River, multiple small scale erosion events have been observed, most notably east of monitoring well series MW-85, where localized spotting was first identified. Exposed portions of the smear zone have been observed on the river bank in this area during low river stages, providing evidence that sheening on the Great Miami River is due to erosion (Chevron 2005). Upon evaluating a variety of bank stabilization engineering alternatives, a multifaceted approach was designed that serves to redirect the River away from the west bank and restore the channel to a more natural floodplain condition. This approach includes implementation of a low-sloping bench with flood-tolerant vegetation, a minimally exposed sheet pile barrier wall, and targeted sediment removal immediately adjacent to the west bank of the Chevron Cincinnati Facility south of the Hooven Ditch (Chevron 2007a) .

The overall goal of the proposed remedy is to ensure that impacted soil currently abutting the Great Miami River is not subject to future erosion, and therefore not a potential source of release to the River. Secondary to this, but of significant importance, the remedy as designed is anticipated to prevent migration of dissolved phase impacts during periods of sustained gradients towards the River, where discharge of groundwater to surface water occurs following floods or rapid declines in surface water elevations. The scope of this monitoring plan will allow Chevron to monitor the condition and effectiveness of the remedy over time and will include collection of qualitative and quantitative data necessary to:

- Monitor the physical state of the various remedy components
- Provide data to define a maintenance and rehabilitation schedule for the system components
- Assess remedy performance to prevent discharge of LNAPL into the River due to potential instability of impacted bank soils
- Evaluate remedy performance to prevent migration of dissolved phase impacts to the River above OEPA surface water standards
- Monitor vertical and horizontal hydraulic gradients along the containment system
- Estimate biodegradation pathways for dissolved phase impacts should they encroach upon the partially penetrating barrier wall
- Provide early warning of potential releases to the River prior to impacting human health or ecological receptors

The remainder of this work plan will define the field methods, monitoring network, quality assurance/quality control measures, reporting activities, and schedule that will be implemented to meet each of these criteria.

1.1 PHYSICAL INSPECTION AND MAINTENANCE

Physical inspection and maintenance of the barrier and bank stabilization measures will consist of a visual inspection program to identify potential damage to the exposed portions of the sheet pile wall, scour of riprap and other river-side material, as well as erosion of flood tolerant vegetation inland of the barrier. If damage, scour, or erosion occurs to the extent that it may impact long-term bank stability, the bank will be restored to pre-existing conditions. The visual inspection program will be conducted annually for the life of the barrier wall as described in the following sections.

1.1.1 CONDITION OF SHEET PILES, RIVER SIDE RIP RAP, AND FILL MATERIAL

Visual inspection of the barrier and fill material will be conducted annually, as well as following a two-year or greater flood event (discharges equal to or greater than 45,000 cubic feet per second). Exposed portions of the steel sheet piles will be visually inspected and the condition of the piling surface and joints will be recorded. The condition of the fill and riprap materials on each side of the barrier will also be inspected and recorded. Any defects or damage will be noted. Chevron will submit a description of the conditions and any necessary repairs to the U.S. EPA within the subsequent monitoring report, per the conditions in the Order and the Operations, Maintenance, and Monitoring (OMM) Plan.

1.1.2 CONDITION OF RIVER BANK AND FLOOD TOLERANT VEGETATION

Visual inspection of the low-sloping bench and west bank of the Great Miami River will be conducted annually, as well as following a two-year or greater flood event. The bench and bank will be inspected for signs of erosion, bank migration or other indications of adverse impacts resulting from installation of the barrier. If greater than 10% of flood-tolerant vegetation in a given area is eroded, turf mats and live stakes will be reapplied to the eroded area and monitored during successive inspections. The inspector will note any defects or damage and describe the scope of repairs to correct the situation. Chevron will submit a description of the scope of the damage and necessary repairs to the U.S. EPA within the next monitoring report.

1.1.3 MONITORING FOR PRESENCE OF SHEENS

If the presence of LNAPL is detected within one or more of the shallow groundwater monitoring wells installed as part of the barrier monitoring network, visual inspection of the river surface will be conducted to identify potential migration of LNAPL to the Great Miami River. LNAPL inspections will be conducted daily until LNAPL is no longer detected within the shallow groundwater monitoring well(s) or until it can be demonstrated that the LNAPL thickness is stable (thickness fluctuates by less the 0.1 feet over four consecutive weekly measurements). Inspection will be conducted at 200-foot intervals along the length of the sheet pile wall at areas of LNAPL encroachment. Following installation of the sheet pile wall and if prompted by the detection of LNAPL in the newly installed wells proposed in this plan, inspection locations will be identified, marked on the surface of the wall, and surveyed.

Visual inspections will be conducted over a five minute interval at each location; the number and approximate size of each distinct sheen event, if any, will be noted. If sheening is observed and it is determined to be originating from the site plume, Chevron will resume continuous containment pumping, per the provisions in the Order and in the *OMM Plan for the Final Groundwater Remedy* (Chevron 2007b). Chevron will determine the location of potential failure within the barrier wall or bank stabilization measures and repair any damage or failures, or will propose alternative corrective actions to U.S. EPA, as discussed below. Chevron will submit a description of the scope of the damage/failures and necessary repairs to the U.S. EPA within the next progress report.

If it is determined that the engineered barrier is not adequate to prevent discharge of LNAPL to the river, Chevron will work with the U.S. EPA to design and implement additional corrective measures within six months of demonstrating failure of the sheet pile wall and bank stabilization measures in accordance with Section VI.14.c.1. of the Administrative Order on Consent.

1.2 GROUNDWATER, HYPORHEIC WATER, AND SURFACE WATER QUALITY MONITORING

A monitoring network will be constructed that will allow for characterization of baseline conditions following installation and subsequent monitoring of groundwater, hyporheic water, and surface water conditions along the lateral extent of the remedy. The performance of the sheet pile wall will be monitored by observing the hydraulic gradients in groundwater and surface water, as well as evaluating groundwater, hyporheic water, and surface water quality over time.

1.2.1 MONITORING WELL NETWORK

The monitoring network will be comprised of three monitoring transects as presented on Figure 1. The transects are proposed at the three depicted locations as described below.

1. Southeast of monitoring well MW-45, at the up-gradient limit of the sheet pile wall.
2. Southeast of well MW-7, in an area of thick smear zone identified during the Cone Penetrometer Test (CPT)/Rapid Optical Screen Tool (ROST) investigation conducted along the west bank in 2004 and 2005.
3. East of monitoring well MW-26R at the down-gradient limit of the sheet pile wall.

1.2.1.1 NESTED GROUNDWATER MONITORING WELLS

Each transect will include a groundwater monitoring nest situated on the interior of the sheet pile wall and a groundwater monitoring nest located outboard of the wall. Three wells will be installed within each nest.
First, a shallow interval screened across the interface of the vadose zone and saturated zone. The screen interval within the shallow well will be determined from the range of historical fluid level elevations recorded in nearby monitoring wells. Second, an intermediate well screened at an elevation across the approximate depth of the sheet pile wall. Third, a deep interval with the top of screen installed approximately ten feet below the bottom of the wall.

The inboard groundwater monitoring nests will be located between 25 and 50 feet from the sheet pile wall. The location of the outboard nests will be sited following construction of the wall and stabilized river bank. The location of these wells will be based upon the final slope of the reconstructed and stabilized river bank, and is a function of the distance to the River surface from the wall. A typical monitoring nest schematic for a nest installed on a steep grade and one depicting a nest installed on a shallow grade are included as Figure 2 and Figure 3, respectively.

1.2.1.2 HYPORHEIC ZONE MONITORING WELLS

A hyporheic zone monitoring well will be installed as part of each monitoring transect. The hyporheic zone can be defined as the subsurface interface between surface water and groundwater; with minimum of 10% stream water (Triska et al 1989). Hyporheic water quality samples will be collected and sampled according to the monitoring schedule. Hyporheic water quality analytical results will be compared to the Ohio Environmental Protection Agency (Ohio EPA), Division of Surface Water screening standards for the Ohio River Basin provided in Ohio Administrative Code (OAC) 3745-1-32, effective date December 30, 2002. The following standards will apply based on the designated uses of the Jordan Creek Segment of the Great Miami River, as defined in OAC 3745-1-21, effective April 1, 2007:

- Aquatic Life Designation: Warm water habitat
- Water Supply Use: Agricultural water supply, industrial water supply
- Recreation Use: Primary contact

A summary of the chemicals of concern and Ohio EPA surface water screening standards are provided in Table 1. The hyporheic monitoring wells will serve as the early warning monitoring system for identifying potential discharge of dissolved phase impacts from the refinery into the River. If reported and validated hyporheic water quality analytical results exceed one or more of the surface water screening standards, the results will be compared to groundwater analytical data to determine if dissolved phase impacts from the facility are the source of impacts. If the pathway from groundwater beneath the facility to the hyporheic zone is determined complete, a confirmation sample will be collected within one month of the identified exceedance and analyzed for the constituents of concern.

Should the analytical results of the confirmation hyporheic water quality sample also exceed the screening standards, Chevron will take steps necessary to install the infrastructure (e.g., blower, protective enclosure, electrical power lines, etc.) and controls, complete final piping connections, and subsequently start up the air sparge system that will be partially installed as part of the final remedy along the west bank of the River. These activities will be completed in coordination with the U.S. EPA in fulfillment of Section VI.14.c.2. of the Administrative Order on Consent.

As described in detail in Section 3.6 of the *Remedial Measures Work Plan for Sheet Pile Barrier and Bank Stabilization along the Great Miami River* (Chevron 2007d), horizontal air sparge lines will be placed on the existing river bed prior to preparation for sheet pile driving activities. In contrast to a conventional air sparge system, where the piping is installed vertically and screened beneath the core of contamination, the current configuration would produce more of a "bubble curtain" creating a region of increased aerobic microbial activity that would accelerate intrinsic biodegradation of dissolved-phase impacts in the groundwater and hyporheic zone.

1.2.1.3 SURFACE WATER MONITORING WELLS

A surface water monitoring well will also be installed with each monitoring transect and will serve as the point of compliance for monitoring the remedy effectiveness. Surface water monitoring wells will be utilized to record surface water elevations in the Great Miami River adjacent to the facility and to collect surface water quality samples for comparison to the Ohio EPA surface water screening standards provided in Table 1. If reported and validated surface water analytical results exceed one or more of the screening standards, the results will be compared to groundwater and hyporheic water data to determine if dissolved phase impacts or LNAPL present in bank soils are the source of impacts to surface water. If this pathway is determined complete, a confirmation sample will be collected within one month of the identified exceedance and analyzed for the constituents of concern. Should the analytical results of the confirmation surface water quality sample also exceed the screening standards, Chevron will coordinate with the U.S. EPA to define the nature and extent of such release, impact of the release on human health or sensitive ecological receptors; and potential corrective measures for mitigating such release in accordance with Section VI.18. of the Administrative Order on Consent.

1.2.2 FREQUENCY AND SCOPE OF MONITORING ACTIVITIES

Fluid level monitoring results will be used in conjunction with visual inspections and water quality analytical data to demonstrate effectiveness of the remedy over time. The following present the frequency and scope of fluid level gauging and water quality monitoring over the life span of the groundwater remedy. Monitoring methods and procedures are provided in Section 2.0.

1.2.2.1 FLUID LEVELS

Fluid levels will be measured in the groundwater, hyporheic water, and surface water monitoring wells on a bimonthly basis, with the frequency increasing to monthly when groundwater elevation falls below 464.8 feet above mean sea level (ft-amsl) in monitoring well MW-20S, in accordance with the general fluid level monitoring schedule established within the *OMM Plan for the Final Groundwater Remedy* (Chevron 2007b). The trigger level (464.8 ft-amsl) for increasing fluid level monitoring frequency, will occur at lower and lower elevations over time as the remedy proceeds. The trigger elevation will be established and tracked as part of the high-grade recovery program. Pressure transducers will also be used to record water elevations in the up-gradient and down-gradient monitoring transects. Pressure transducers will be deployed in the shallow, intermediate, and deep groundwater monitoring wells on either side of the wall, within these two transects, as well as the surface water monitoring wells.

Fluid level data will be used to determine the path of groundwater on the interior and exterior portions of the sheet pile wall. Horizontal flow paths will be evaluated by preparing site wide and detailed potentiometric surface maps. Potentiometric surface maps will be reviewed in order to determine if and where sustained gradients occur perpendicular to the wall. Vertical gradients will be assessed by evaluating fluid level data from the nested groundwater monitoring wells on each side of the wall and comparing these to the surface water elevations. Vertical gradients will be used to assess the potential for sustained flow of impacted, shallow groundwater beneath the wall, potentially discharging to the hyporheic zone and surface water.

1.2.2.2 WATER QUALITY SAMPLING

Groundwater, hyporheic water and surface water quality monitoring will be performed on a quarterly basis for the first two years following installation of the monitoring network in order to establish baseline conditions. Samples will be collected and analyzed on a semiannual basis for the next two years, annually for the following ten years, and biennially thereafter. Sampling events will be staggered so that each subsequent monitoring event is conducted in the ensuing quarter for that calendar year in order to evaluate potential seasonal variations on water quality.

1.2.2.3 CONSTITUENTS OF CONCERN

Groundwater, hyporheic water, and surface water samples will be analyzed for the contaminants of concern for groundwater established in the Administrative Order on Consent per the frequency established in the preceding section. The contaminants of concern are provided on Table 1 with a comparison to the surface water quality screening standards and include arsenic, benzene, chlorobenzene, ethylbenzene, lead, toluene, and total xylenes.

1.2.2.4 NATURAL ATTENUATION INDICATORS

As outlined in the *Remediation Implementation Plan* (Chevron 2007c) and the *OMM Plan for the Final Groundwater Remedy* (Chevron 2007b), natural attenuation mechanisms are anticipated to be the principal mechanism for continued reduction in the mobility, toxicity, and/or bioavailability of petroleum contaminants over the life of the groundwater remedy. Intrinsic biodegradation is the primary natural attenuation mechanism linked to LNAPL degradation. Biodegradation pathways for LNAPL impacts are as follows:

1. Dissolution of constituents from LNAPL in smear zone soils and subsequent biodegradation. Aerobic biodegradation is expected to be an important process at the periphery of the smear zone. Anaerobic biodegradation is expected to be the dominant process within the smear zone and within the transition zone immediately down-gradient of the smear zone. This trend of aerobic to anaerobic biodegradation is expected to occur in both the lateral and vertical dimensions:

2. Volatilization of constituents from LNAPL in smear zone soils and subsequent biodegradation in overlying soil gas. Degradation in this phase is thought to be primarily aerobic.

The volatilization of constituents is being evaluated as part of facility-wide performance monitoring stipulated within the *OMM Plan for the Final Groundwater Remedy* (Chevron 2007b) and will not be conducted as part of the monitoring associated with the sheet pile wall and stabilized river bank. Aerobic and anaerobic biodegradation mechanisms will be evaluated to demonstrate degradation pathways in groundwater and the hyporheic zone, should LNAPL and dissolved phase impacts encroach upon the sheet pile wall. Groundwater samples will be analyzed semiannually over the first two years of monitoring (or more simply stated during every other groundwater sampling event during the first two years of monitoring per the schedule provided in Section 1.2.2.2) in order to determine background conditions in the aquifer and hyporheic zone. Groundwater samples will be analyzed annually for the next ten years and biennially thereafter to evaluate spatial and temporal trends in aerobic and anaerobic conditions and degradation pathways.

Initially samples will be collected from the inboard and outboard groundwater monitoring wells and hyporheic zone wells installed in the southern-most and middle monitoring transects. Samples will be analyzed for constituents identified on Table 2 including alkalinity, carbon dioxide, calcium, chemical oxygen demand, chloride, iron (ii) and iron (iii), dissolved and total manganese, methane, nitrate, nitrite, and ammonia as nitrogen, total Kjeldahl nitrogen, potassium, sodium, sulfate, sulfide, and total organic carbon. Note that Table 2 is analogous to Table 3-3 of the *OMM Plan for the Final Groundwater Remedy* (Chevron 2007b), and the data collected along the River will also be used in evaluating plume conditions and quantifying monitored natural attenuation rates. Revisions to this analyte list may be proposed in the future based on ongoing results and evaluations. The intent of the natural attenuation monitoring for this portion of the remedy is to collect data to define baseline conditions and then to make adjustments as warranted based on initial results. Changes to the location, frequency, and/or requested analyses may be proposed over time based on remedy progress and evolving industry practices. As Chevron identifies modifications and improvements, it will submit them for U.S. EPA-approval as an amendment to this performance monitoring plan, and in conjunction with the overall site-wide groundwater monitoring program, as described in the *OMM Plan for the Final Groundwater Remedy* (Chevron 2007b).

2.0 MONITORING METHODS AND PROCEDURES

Monitoring well installation, fluid level gauging, water quality sampling, and laboratory analysis will be conducted in general accordance with the Quality Assurance Project Plan (QAPP) approved pursuant to the 1993 RFI/CMS Order with subsequent U.S. EPA-approved revisions (Chevron 1995), as stipulated in Section VI.12.b. of the Administrative Order on Consent. Additional description of the methods and procedures are provided for reference herein. Deviation from the procedures and methods specified in the QAPP will be noted in routine reports submitted under this Plan, and amendments to the QAPP may be requested in writing to the U.S. EPA, from time to time as warranted by changes in the site conditions or standard industry practices.

2.1 SOIL BORING INSTALLATION

Soil borings will be continuously collected using a continuous core or split spoon sampler to the total depth of the boring. Soil samples will be collected in accordance with the following procedures:

- Field team personnel wearing nitrile gloves will extract the samples from the continuous sampler. Soil from the uppermost section of the sampler will be discarded, as it may contain borehole slough.
- Soil samples with any visible oil-staining or with total organic vapor concentrations greater than 50 parts per million (ppm) will be retained for potential laboratory analysis.
- The remaining soil from each borehole will be used by the onsite geologist to produce a lithologic log in general accordance with ASTM standards. Additional information, such as odors, discoloration, artificial/non-native debris, and observations pertaining to potential hydrocarbon impacts, will also be noted on the boring logs.

2.1.1 TOTAL ORGANIC VAPOR SCREENING

Soil samples will be screened for total organic vapor using a photoionization detector (PID). The PID will be calibrated daily, in accordance with the manufacturer's guidelines, to a factory-prepared 100 parts per million isobutylene standard. Each sample will be allowed to equilibrate to a minimum of 18.3º Celsius (65º Fahrenheit) before screening for total organic vapors. The highest total organic vapor measurement for each sample shall be recorded on the borehole log in ppm, relative to the calibration standard.

2.1.2 SOIL SAMPLE COLLECTION AND LABORATORY ANALYSIS

Soil samples may be collected for laboratory analysis based on the field screening results and physical observations. The samples will be collected and analyzed in general accordance with the *Test Methods for Evaluating Solid Waste, SW-846* (U.S. EPA 1997). Soil samples with visible oil-staining or total organic vapor concentrations greater than 50 ppm, and which are from a location where data regarding the smear zone extent has not been previously collected, will be analyzed for volatile organic constituents (VOCs) via U.S. EPA Method 8260B, semivolatile organic constituents (SVOCs) using U.S. EPA Method 8270C, and/or metals via U.S. EPA Method 6000 and 7000 series methods.

The lids on each sample container shall be tightly secured and the sample label filled out completely including sample identification, sample interval, date and time of collection, project name, client name, field personnel initials, requested analyses, and preservation methods. The sample containers will be placed on ice and proper custody maintained. Glass containers will be protected against breakage during transport to the laboratory. The soil samples will be submitted to an accredited analytical laboratory. A chain-of-custody form, temperature blank, and trip blank (to be analyzed for VOCs via U.S. EPA Method 8260B) will be included with each sample cooler shipped to the laboratory. Quality assurance/quality control measures and data validation will be conducted according to the procedures outlined in Section 3 of this monitoring plan.

2.1.3 DECONTAMINATION PROCEDURES

Before arriving at the site, the drill rig, tools, and accessories will be thoroughly decontaminated with a pressure washer or steam cleaner. Down-hole equipment will be decontaminated between borings at the Chevron Cincinnati Facility using a hot water pressure washer. Soil sampling equipment will be decontaminated between sample intervals using a phosphate-free detergent wash, a potable water rinse, followed by a distilled water rinse. Soil cuttings will be collected and consolidated at the Chevron Cincinnati Facility for appropriate handling and disposal. Decontamination fluids will be collected and disposed of into the on-site wastewater treatment facility.

2.2 GROUNDWATER MONITORING WELL CONSTRUCTION

After advancement of a soil boring to the total depth, a groundwater monitoring well will be installed using ten feet of two-inch diameter, 0.010-inch factory-slotted polyvinyl chloride (PVC) pipe inserted through the hollow stem of the augers. PVC flush-threaded blank casing shall be installed from the top of the screened interval to approximately two to three feet above the ground surface. Well screen and riser pipe will be kept in plastic wrap until use, and handled with disposable nitrile gloves during installation.

A filter pack consisting of clean, graded, 10/20 silica sand will be placed around the annulus of the PVC pipe to a minimum depth of two feet above the top of the screened interval. An annular seal consisting of approximately two feet of hydrated benseal granular bentonite will be placed above the filter pack. Portland cement grout (95% cement, 5% powdered bentonite) will be placed above the seal to approximately one foot below the ground surface. The inboard groundwater monitoring wells will be installed vertically and the outboard wells will be installed at a predetermined angle. Typical well construction schematics for the vertical and angled groundwater monitoring wells are shown on Figure 4.

2.3 HYPORHEIC ZONE MONITORING WELL CONSTRUCTION

The hyporheic zone monitoring wells will be installed at a pre-determined angle up to 45 degrees from vertical to facilitate placement of the screened interval below the bed of the Great Miami River. The hyporheic wells will be installed by driving a three-inch stainless steel casing into the river bed. The orientation of the well will be dependant upon the final grade of the reconstructed river bank. The hyporheic zone monitoring well will be constructed using a ten foot length of three-inch diameter continuous wire wrapped stainless steel screen. Stainless steel threaded blank casing will be installed from the top of the screened interval to approximately two to three feet above grade.

The hyporheic zone monitoring wells will be installed with an extended screen interval (i.e., 10-feet) to allow for flexibility in determining the appropriate sampling interval during each monitoring event over the course of the remedy. Inflatable packers will be used to isolate one to two foot intervals within the well prior to collecting water quality samples. A typical well construction schematic is shown on Figure 4.

2.4 SURFACE WATER MONITORING WELL CONSTRUCTION

The surface water monitoring wells will also be installed at an angle from near vertical up to 45 degrees from vertical based upon the final grade of the reconstructed river bank. The surface water monitoring wells will be installed by driving a two-inch stainless steel casing to a minimum depth of ten feet below the river bed. Two-inch diameter, continuous wire wrapped stainless steel screen will be installed, such that the bottom of the screen interval is coincident with the river bed. Stainless steel threaded blank casing will be installed from the top of the screened interval to approximately two to three feet above grade. A typical well construction schematic is shown on Figure 4.

2.5 MONITORING WELL COMPLETION AND LICENSED SURVEY

A lockable well cap will be installed at the top of each monitoring well. The monitoring wells shall be completed above ground surface inside four-inch steel protective casings with a lockable lid. The inboard monitoring wells will be completed within stainless steel protective casings installed in a four foot by four foot by one foot concrete pad. The outboard wells will also be completed within stainless steel protective casings and attached to the exposed portions of the sheet pile wall.

The monitoring well nests on the inboard and outboard portions of the barrier wall will be protected from large sediment and debris transported by the River during flood events via three six-inch bollards, with one installed immediately up-gradient, a second to the east, and a third to the west of the monitoring nests. The bollards will be driven into the stream bed to a depth of approximately 30-feet below grade. The top of the bollard will terminate at an elevation similar to that of the monitoring wells within the nest.

A well log and drilling report (ODNR Form 7802.03) will be submitted to the Ohio Department of Natural Resources following installation of the groundwater and hyporheic water monitoring wells. The top of casing and surface elevations, as well as, northing and easting coordinates of the groundwater, hyporheic water and surface water monitoring wells will be measured by a licensed surveyor, relative to mean sea level and the state plane coordinate system. A permanent mark on the well casing will be established as the measuring point. Subsequent fluid levels will be measured relative to this mark.

2.6 MONITORING WELL DEVELOPMENT

A minimum of 24-hours following construction, the monitoring wells will be developed to remove accumulated sediments from the boring and well casing, introduced during drilling and well construction activities. Newly installed wells will be developed by mechanically surging the well followed by over-pumping until stabilization of water quality parameters, or a minimum of 10 casing volumes of water have been removed.

Prior to mechanical surging, a minimum of one well volume will be evacuated from the well to prevent sand locking of the surge tool. Surging will consist of forcing water into and out of the formation using a surge block. The surging action will be relatively gentle to avoid collapsing the well screen or slumping formation material into the screen. Surging will be concentrated over five foot intervals starting at the top of the screen to avoid sand locking the surge block.

Water in the newly installed wells will then be pumped until stabilization of pH, temperature, specific conductivity, dissolved oxygen, oxygen-reduction potential (ORP), and turbidity (field parameters), measured at regular intervals throughout the evacuation process. The volume evacuated from each well, field parameters, and physical characteristics of the purge water (color, relative turbidity, sediments, etc.) will be recorded at regular intervals during development activities.

2.7 FLUID LEVEL GAUGING

Fluid levels will be measured using manual and automated methods to evaluate horizontal and vertical gradients across the monitoring transects as described in Section 1.2.2.1. Fluid level gauging activities will be combined with facility-wide monitoring as stipulated within the *OMM Plan for the Final Groundwater Remedy* (Chevron 2007a), when feasible.

2.7.1 MANUAL GAUGING

Fluid levels within each of the monitoring wells will be measured within a 24-hour period. Fluid level measurements will be conducted using an interface probe accurate to 0.01-feet. The measurements will be made from the pre-marked (surveyed) measuring point on the well casing. Manufacturer's instructions shall be followed to ensure proper care of the fluid level probe. The exposed portion of the tape and the probe will be decontaminated before performing measurements at each monitoring well.

2.7.2 PRESSURE TRANSDUCERS

Pressure transducers will be deployed in the groundwater and surface water monitoring wells in the up-gradient and down-gradient monitoring transects. Transducers will be programmed to record elevations on an hourly basis. The data will be downloaded from the transducers at least once each quarter. Each transducer has a memory capacity of one megabyte, and the download frequency will be sufficient so as not to exceed storage capacity.

2.8 GROUNDWATER AND HYPORHEIC WATER SAMPLING PROCEDURES

The groundwater and hyporheic monitoring wells will be purged and sampled using a low flow methodology to prevent potential disturbance of the water conditions within the formation, as well as the groundwater-surface water mixing zone. Inflatable packers will be used to isolate the one to two foot interval within the hyporheic zone monitoring well that is projected to be situated within the mixing zone based upon the elevation of groundwater and current elevation of the river bed.

Low flow sampling will conform to U.S. EPA recommended procedures (Puls and Barcelona 1996). Portable submersible pumps will be installed so that the pump intake height is located in the middle of the screen interval in the groundwater monitoring wells and within the isolated portion of the screen within the hyporheic monitoring wells using the inflatable packers. The flow rate will be maintained between 0.1 and 0.5 liters per minute to minimize drawdown, undue pressure, temperature, or physical disturbances to the water over the sampling interval. The water level and field parameters will be recorded over successive time intervals. The following stabilization criteria shall be met over three successive readings before collecting water samples:

- pH ± 0.5,
- Specific conductivity ± 5%, and
- Turbidity ± 10% or <10 nephelometric turbidity units.
- DO
- ORP

Field parameters will be compared in the hyporheic water, groundwater, and surface water monitoring wells sampled within the same transect to document that water quality in the hyporheic wells is representative of the groundwater-surface water mixing zone. Physical characteristics of the water will be noted and recorded during sampling (e.g. sediment, color, odor, etc.). The submersible pump, discharge hose, and tethers will be decontaminated prior to purging each well.

2.9 SURFACE WATER SAMPLING PROCEDURES

The casing volume in the surface water monitoring well will be calculated based on the measured fluid level, total well depth, and well diameter. The casing volume will be evacuated a minimum of three times using a submersible pump. Stabilization of field parameters over three successive casing volumes will be documented before discontinuing evacuation activities. The surface water monitoring wells will be purged using portable submersible pumps. The pump and discharge tubing will be slowly lowered into the well to minimize agitation of sediment in the well. Field parameters including pH, specific conductance, temperature, dissolved oxygen, ORP, and turbidity will be measured and evaluated during well evacuation to ensure a representative sample is collected from each well. Field parameters will be recorded in the field log. Physical characteristics of the water will be noted and recorded during sampling (e.g. sediment, hydrocarbon sheen, color, odor, etc.). The submersible pump, discharge hose, and tethers will be decontaminated prior to purging each monitoring well.

2.10 WATER QUALITY SAMPLE COLLECTION AND LABORATORY ANALYSIS

Water quality samples will be collected upon completion of evacuation. Field personnel will wear disposable nitrile gloves to prevent contamination of samples. Sample agitation will be minimized and water will be transferred directly from the pump discharge tubing into the sample containers. Sample bottles will have preservatives added in the laboratory before being sent to the site. The samples will be collected and analyzed in general accordance with the *Test Methods for Evaluating Solid Waste, SW-846* (U.S. EPA 1997), and the U.S. EPA-approved QAPP.

Groundwater samples will be submitted for analysis of the constituents of concern outlined in Section 1.2.2.3 via U.S. EPA Method 8260B and U.S. EPA Method 6020. In addition samples from the groundwater, hyporheic water, and surface water wells installed within the middle two monitoring transects will be submitted for laboratory analysis of natural attenuation indicators discussed in Section 1.2.2.4 using U.S. EPA and ASTM approved methods.

The lids on each sample container will be tightly secured and the sample label filled out completely including sample identification, date and time of collection, project name, client name, field personnel initials, requested analyses, and preservation methods. The sample containers will be placed on ice and proper custody maintained. Glass containers will be protected against breakage during transport to the laboratory. The water samples will be submitted to a U.S. EPA Region 5 accredited analytical laboratory. A chain-of-custody form, temperature blank, and trip blank (to be analyzed for VOCs via U.S. EPA Method 8260B) will be included with each sample cooler shipped to the laboratory. Quality assurance/quality control measures and data validation will be conducted according to the procedures outlined in Section 3 of this monitoring plan.

3.0 QUALITY ASSURANCE/QUALITY CONTROL

The overall goal for quality assurance/quality control (QA/QC) for this monitoring plan is to develop and implement procedures for sampling, chain-of-custody, laboratory analysis, validation, and reporting that will provide defensible data for evaluating the performance of the remedy implemented along the west bank of the Great Miami River. Specific procedures for chain-of-custody, laboratory instrument calibration, laboratory analysis, reporting limits, data reporting, internal quality control, audits, preventive maintenance of field equipment, and corrective action are described in the QAPP that was approved by the U.S. EPA pursuant to the 1993 RFI/CMS Order with subsequent U.S. EPA-approved revisions (Chevron 1995), as stipulated in Section VI.12.b. of the Administrative Order on Consent. A summary of the QA/QC and data validation objectives are provided herein.

3.1 LEVEL OF QA/QC EFFORT

The QA/QC process provides quantitative and qualitative measures of the ability to produce defensible results through a properly designed sampling and analysis program. The specific objectives of the QA/QC and data validation program are to:

- Ensure that all procedures are documented, including any changes from the approved methodologies.
- Ensure that all sampling and analytical procedures are conducted according to sound scientific principles.
- Monitor the performance of the field sampling team and laboratory with a systematic audit program and provide for corrective action necessary to assure quality.
- Evaluate the quality of the analytical data through a system of quantitative and qualitative criteria.
- Ensure that all data and observations are properly recorded and archived.

3.1.1 FIELD QUALITY CONTROL SAMPLES

The level of quality control effort will be consistent with that typically stipulated within the *Test Methods for Evaluating Solid Waste, SW-846* (U.S. EPA 1997) for a RCRA Facility Investigation. The level of effort for field sample activities is summarized below.

1. <u>Blind Duplicate Samples</u>: Blind duplicate (field duplicate) samples will be collected to evaluate precision associated with the reproducibility of sampling techniques and the homogeneity of sample matrices. Duplicate

samples will be collected for each matrix at a frequency of 5% or one per every 20 samples collected and submitted for laboratory analysis. If less than 20 samples are collected during a particular sampling event, one blind duplicate sample will be collected. Since the duplicate will be "blind" to the laboratory, it will have a coded identity on its label and on the chain-of-custody record form. Blind duplicate samples will be submitted for each sample media analyzed. The actual sampling location and identification will be recorded on the field forms.

2. Trip Blanks: One trip blank will be submitted for volatile analysis with each cooler containing solid and aqueous samples requiring VOC analyses. Trip blanks are supplied by the laboratory with the sampling containers at the start of field activities and accompany the sample containers throughout the project.

3. Equipment and Field Blanks: Equipment and field blanks will be prepared and submitted for laboratory analysis and will be used to determine if cross-contamination has occurred during sampling, and to verify that equipment decontamination procedures are effective. Equipment blanks will be collected when disposable or dedicated equipment is not used. Equipment and field blanks are submitted for analysis of the same constituent list required for the associated field samples. Equipment and field blanks will be preserved in the same manner as the associated samples. Equipment and field blanks will be shipped with the field sample containers. At least one equipment blank and one field blank will be collected per sampling event, with a minimum frequency of one equipment blank and one field blank collected per day.

3.2 DATA VALIDATION PROCEDURES

All data generated through field activities or by the laboratory, will be validated prior to reporting. This section covers procedures to compile, validate, and report the data collected during the sampling activities.

3.2.1 TIER I DATA VALIDATION

In addition to the field data validation procedures, the Tier I data package is performed to document that all samples in the data set were analyzed according to the project requirements, and that the laboratory analytical report is complete. A Tier I data validation checklist will be prepared in an electronic format for each laboratory analytical sample group. Tier I data validations can be performed by any competent person with knowledge of the project requirements. The Tier I evaluation will include a review of the following elements:

- Comparison of sampling dates to sample extraction dates, and analysis dates to check that samples were extracted and/or analyzed within proper holding times.

- Review of analytical methods and required detection limits to verify conformance.
- Review of the constituent list and reporting limits to verify conformance with project requirements.
- Review chain-of-custody forms to verify that samples were maintained under proper custody.
- Review of field forms against the laboratory report to check for correct sample identifies, collection times, and QA/QC samples.
- Review of sample results against previous reported results to verify that samples were not mislabeled or otherwise appear anomalous. .

3.2.2 TIER II DATA VALIDATION

In addition to the Tier I validation requirements the Tier II evaluation will include a review of the results of the analytical procedures, a review of field and laboratory quality control tests, assessment of duplicate sample repeatability, and a description of any qualified or rejected data. Equipment blanks will be used to evaluate samples collected on the same day. Trip blanks will be used to evaluate data shipped in the same container. Field duplicate samples will used as a measure of repeatability.

For Tier II data validations, a data validation report is produced for each batch of samples. Tier II data validations should be performed by an individual who is familiar with the actual laboratory methods used in generating the data set, and who has a reasonable degree of independence from the project team. Only media analyzed for the constituents of concern will receive a Tier II evaluation. Natural attenuation indicators will not be included in the Tier II review process. The Tier II evaluation will include a review of all Tier I elements as well as the following:

- Review of field and laboratory blanks to evaluate possible contamination sources; consideration should be given to preparation techniques and frequencies, as well as the analytical results.
- Review of field duplicate data for evaluation of field and laboratory precision.
- Review of laboratory quality assurance data (MS/MSD recoveries and RPD calculations, surrogate spike recoveries, and LCS recoveries) for compliance with method acceptance criteria.
- Review of the analytical results to verify compliance with the specified project goals.
- Review of laboratory summary of tuning and calibration checks (if available).

4.0 REPORTING

Results of the River Monitoring Program will be included in the routine monitoring reports to be submitted to the U.S. EPA, per the Order and the *OMM Plan for the Final Groundwater Remedy* (Chevron 2007b). The river monitoring results section of that report will include:

- Copies of visual inspection logs and field records, laboratory analytical results, chain-of-custody documentation, laboratory quality assurance reports, and data validation reports.
- Description of inspection and field methods used to collect performance monitoring data; including a detailed overview of any deviations from the methods and procedures outlined in the QAPP or provided herein.
- Description of the physical inspection activities including condition of the exposed potions of the sheet pile wall, backfill material, rip rap, and flood tolerant vegetation, as well as results of LNAPL sheening inspections (if required).
- Summary of any damage to the sheet pile wall and/or bank stabilization measures and completed repairs.
- Summation of fluid level monitoring activities including potentiometric surface maps for bimonthly gauging events and evaluation of vertical gradients perpendicular to the west bank of the River.
- Review of groundwater, hyporheic water, and surface water quality monitoring including tabular and graphical summaries and a comparison of the hyporheic and surface water quality analytical results to the surface water screening standards (Table 1).
- Comparison of water quality analytical results to those reported from previous monitoring events to identify any potential trends in the water quality along the extent of the remedy.
- Evaluation of the natural attenuation indicators to identify the pathway and magnitude of aerobic and anaerobic biodegradation processes, should dissolved phase impacts encroach upon the sheet pile wall.
- Discussion of the performance of the barrier over the reporting period and any proposed maintenance activities to the sheet pile wall or bank stabilization measures to be undertaken in the subsequent reporting period.
- Description of contingency measures, if necessitated to prevent migration of LNAPL and dissolved phase impacts into the Great Miami River.
- Synopsis of notifications, if any, as required under Section VI of the Administrative Order on Consent.

5.0 REFERENCES

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TABLE 1. CONSTITUENTS OF CONCERN AND SURFACE WATER SCREENING STANDARDS, PERFORMANCE MONITORING PLAN, SHEET PILE BARRIER ALONG GREAT MIAMI RIVER, CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Constituents of Concern	Aquatic Life Standard (mg/L)	Human Health (mg/L)	Agricultural Water Supply (mg/L)
Arsenic (dissolved)	0.15	not applicable	
Arsenic (total)	0.15		0.1
Benzene	0.16	0.71	
Chlorobenzene	0.047	21	
Ethylbenzene	0.061	29	
Lead (dissolved)	$e^{(1.273\ [\ln H]\ -\ 4.237)} \times 10^{-3}$	not applicable	
Lead (total)	$e^{(1.273\ [\ln H]\ -\ 4.003)} \times 10^{-3}$	insufficient data	0.1
Toluene	0.062	200	
Xylenes	0.027		

NOTES:

Beneficial use designations of the Jordan Creek Segment of the Great Miami River are as follows:

Aquatic Life:	warm water habitat
Water Supply:	agricultural water supply, industrial water supply
Recreation:	primary contact

Surface waters shall be free from floating oils and shall at no time produce a visible sheen or color film. Levels of oils or petrochemicals in the sediment or on the banks of a watercourse which cause deleterious effects to the biota will not be permitted.

ln H - the natural logarithm of water hardness
mg/L - milligrams per liter

TABLE 2. MONITORED NATURAL ATTENUATION CONSTITUENT LIST, PERFORMANCE MONITORING PLAN, SHEET PILE BARRIER ALONG GREAT MIAMI RIVER, CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Parameter	Decision Rule[k]	Data Use
Alkalinity (CO_2, HCO_3^-, CO_3^{-2})	Used for charge balance: if charges do not balance then this indicates at least one of the ions was measured incorrectly, or a major ion was not included in the analyte list. Increasing alkalinity from up-gradient to within smear zone indicates biodegradation processes.	Used for charge balance during major ion analysis[b,c] Changes in alkalinity can result from biological activity in ground water through production of carbon dioxide (CO_2)[a,h] A measure of the buffering capacity of ground water to pH changes[a,b,d]
Ammonia as Nitrogen	Increasing ammonia from up-gradient to within the smear zone indicates anaerobic biodegradation via nitrate reduction.	
Calcium (Ca^{+2})	Used for charge balance: if charges do not balance then this indicates at least one of the ions was measured incorrectly, or a major ion was not included in the analyte list.	Used for charge balance during major ion analysis[b,c]
Carbon Dioxide(CO_2)		Can act as an electron acceptor for anaerobic microorganisms[a] Byproduct of some degradation pathways[a]
Chloride (Cl^-)	Used for charge balance: if charges do not balance then this indicates at least one of the ions was measured incorrectly, or a major ion was not included in the analyte list.	Used for charge balance during major ion analysis[b,c] Chloride can be from other sources such as road salt, general waste, etc.[b] Can be used as a conservative tracer to determine ground-water flow rates[a]

TABLE 2. MONITORED NATURAL ATTENUATION CONSTITUENT LIST, PERFORMANCE MONITORING PLAN, SHEET PILE BARRIER ALONG GREAT MIAMI RIVER, CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Parameter	Decision Rule[k]	Data Use
Iron (II) (Fe^{+2})	Increasing Iron (II) from up-gradient to within smear zone indicates anaerobic biodegradation via iron reduction.	May indicate an anaerobic degradation process that transforms vinyl chloride, or BTEX compounds[a,d,h]
Magnesium (Mg^{+2})	Used for charge balance: if charges do not balance then this indicates at least one of the ions was measured incorrectly, or a major ion was not included in the analyte list.	Used for charge balance during major ion analysis[b,c]
Manganese (Mn^{+2}), Mn^{+3}, Mn^{+4})	Increasing Mn (II) from up-gradient to within smear zone indicates anaerobic biodegradation via manganese reduction.	To determine if anaerobic biological activity is dissolving manganese from aquifer matrix material[a,d,h]
Methane (CH_4)	Increasing Methane from up-gradient to within smear zone indicates anaerobic	Methane is a by-product of methanogenesis[a,h] Associated with conditions that promote reductive dechlorination[a,h]
Nitrate (NO_3^-)	Decreasing nitrate from up-gradient to within smear zone indicates anaerobic biodegradation via nitrate reduction.	Nitrate may act as a medium for growth of microorganisms for anaerobic degradation, if oxygen is deplete[a,h]
Nitrites (NO_2^-)	Increasing nitrite from up-gradient to within smear zone indicates anaerobic biodegradation via nitrate reduction.	Is an intermediate during the denitrification processes. Product of ammonia oxidation by aerobic microorganisms. Toxic by-product of denitrification of nitrate[d]
Oxidation –Reduction Potential (ORP or sometimes Eh)	If ORP is not reasonably correlated with dissolved oxygen concentrations, then this may indicate that one or both of these parameters is measured incorrectly.	Used as stabilization parameter during ground-water sampling[f] Used for determining the presence of oxygen in ground water (Oxidation state)[b,h] Frequently, the electrode potentials measured in the field must be corrected to standard conditions[a]

TABLE 2. MONITORED NATURAL ATTENUATION CONSTITUENT LIST, PERFORMANCE MONITORING PLAN, SHEET PILE BARRIER ALONG GREAT MIAMI RIVER, CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Parameter	Decision Rule[k]	Data Use
Oxygen, Dissolved (O_2)	Decreasing oxygen from up-gradient to within the smear zone indicates aerobic biodegradation via oxygen reduction.	Used as stabilization parameter during groundwater sampling and aids in determining the redox regime[f] Used for determining the concentration of oxygen in ground water[a,h]
pH	Used for charge balance: if charges do not balance then this indicates at least one of the ions was measured incorrectly, or a major ion was not included in the analyte list.	Used for charge balance during major ion analysis[b,c] Used as stabilization parameter during groundwater sampling[f] Chemical and biological reactions are pH dependent[h]
Potassium (K^+)	Used for charge balance: if charges do not balance then this indicates at least one of the ions was measured incorrectly, or a major ion was not included in the analyte list.	Used for charge balance during major ion analysis[b,c]
Specific Electrical Conductance (SEC) (also commonly referred to as Conductivity or Specific Conductance)	Used as indicator of TDS. No specific decision rule for this analyte.	Used for charge balance during major ion analysis[b,c] Used as an estimate of Total Dissolved Solids[e] Used as a stabilization parameter during groundwater sampling[f] Directly related to ion concentration in solution and therefore may indicate total number of ions[a]
Sodium (Na^+)	Used for charge balance: if charges do not balance then this indicates at least one of the ions was measured incorrectly, or a major ion was not included in the analyte list.	Used for charge balance during major ion analysis[b,c]
Sulfate (SO_4^{-2})	Used for charge balance: if charges do not balance then this indicates at least one of the ions was measured incorrectly, or a major ion was not included in the analyte list.	Used for charge balance during major ion analysis[b,c] Sulfate may act as an electron acceptor for anaerobic degradation[a,h]

TABLE 2. MONITORED NATURAL ATTENUATION CONSTITUENT LIST, PERFORMANCE MONITORING PLAN, SHEET PILE BARRIER ALONG GREAT MIAMI RIVER, CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Parameter	Decision Rule[k]	Data Use
Sulfide (S^{-2})	Increasing sulfide from up-gradient to within the smear zone indicates anaerobic biodegradation via sulfate reduction.	Sulfide may be produced by sulfate reduction by sulfate-reducing bacteria, primarily in the form of hydrogen sulfide (H_2S). Tests are typically for H_2S. the presence of sulfide is a good indication that sulfate reduction is on-going[d,h]
Temperature	Groundwater temperatures within the general range of 10 to 35^{o}C are optimum for biodegradation. Temperatures outside of this range would indicate biodegradation is possible but the rates may be lower than within the optimum range.	Used to support the evaluation of charge balance during major ion analysis[b,c] Used as stabilization parameter during groundwater sampling[f] Chemical and biological reactions are temperature dependent[a,h] Affects the solubility of dissolved gases[a]
Total Kjeldahl Nitrogen	Used for estimating speciation of nitrogen. No specific decision rule for this analyte; used in conjunction with the other nitrogen analyses.	
Total Inorganic Carbon (CO_2, HCO_3^-, CO_3^{-2})[2]		Used for charge balance during major ion analysis[b,c] Changes in alkalinity can result from biological activity in ground water through production of carbon dioxide[a,h] A measure of the buffering capacity of ground water of pH changes[a,b,d]
Turbidity	Used to calibrate any field colorimetric tests. No specific decision rule for this analyte.	Used as stabilization parameter during groundwater sampling[f] Represents fine particles suspended in water, which can be correlated to TDS and TSS[f]
Biologically Available Iron (III) (Fe^{+3})		Iron (III) may serve as the terminal electron acceptor for the destruction of petroleum hydrocarbons[a]
Total Organic Carbon (TOC)		The rate of migration of various contaminants in ground water is dependent upon the amount of TOC in the aquifer matrix[a,d]

TABLE 2. MONITORED NATURAL ATTENUATION CONSTITUENT LIST, PERFORMANCE MONITORING PLAN, SHEET PILE BARRIER ALONG GREAT MIAMI RIVER, CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Parameter	Decision Rule[k]	Data Use
		May also preferentially sorb some metals, organics and radionuclides[d,g,h]

NOTES:
Adapted from United States Environmental Protection Agency. 2000. Framework for Monitoring Natural Attenuation Decisions for Ground Water. United States Environmental Protection Agency Region 5. September 19, 2000: Table 3 *Uses of Indicator Parameters*

[a] United States Environmental Protection Agency. 1998. Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water. EPA/600/R-98/128. *By* : Wiedemeier, T.H., M.A. Swanson, D.E. Moutoux, E.K. Gordon, J.T. Wilson, B.H. Wilson, D.H. Kampbell, P.E. Haas, R.N. Miller, J.E. Hansen, F.H. Chapelle for the National Risk Management Research Laboratory, Ada, Oklahoma.
[b] Hem, J.D. 1985. Study and Interpretation of the Chemical Characteristics of Natural Water. U.S. Geological Survey Water-Supply Paper 2254, third edition. 263 pp.
[c] Hounslow, A.W. 1995. Water Quality Data - Analysis and Interpretation. CRC Lewis Publishers. 397 pp.
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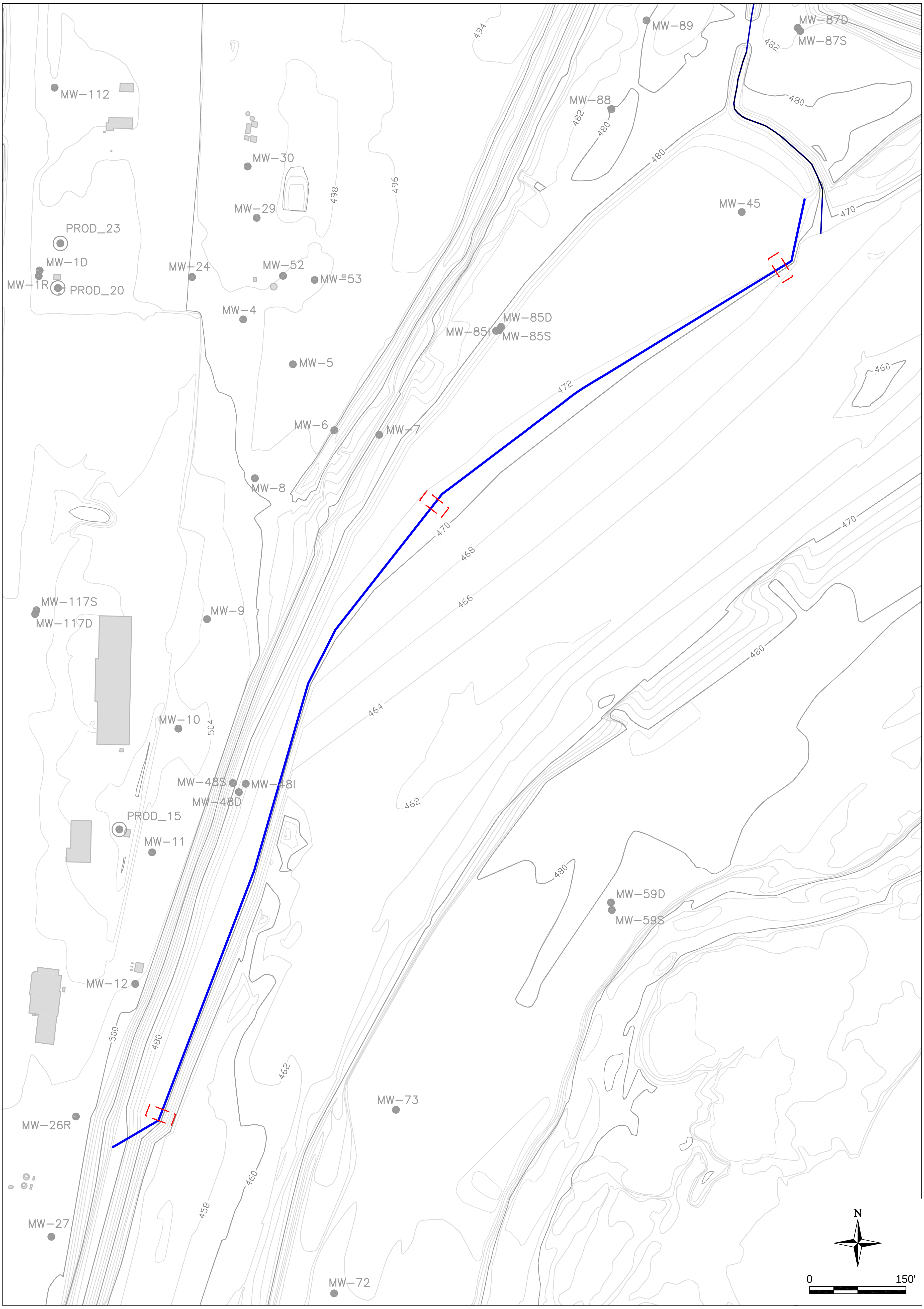

EXPLANATION

	PROPOSED MONITORING WELL TRANSECT
MW-27	EXISTING MONITORING WELL AND DESIGNATION
PROD_12	EXISTING PRODUCTION WELL AND DESIGNATION
	PROPOSED BARRIER ALIGMENT

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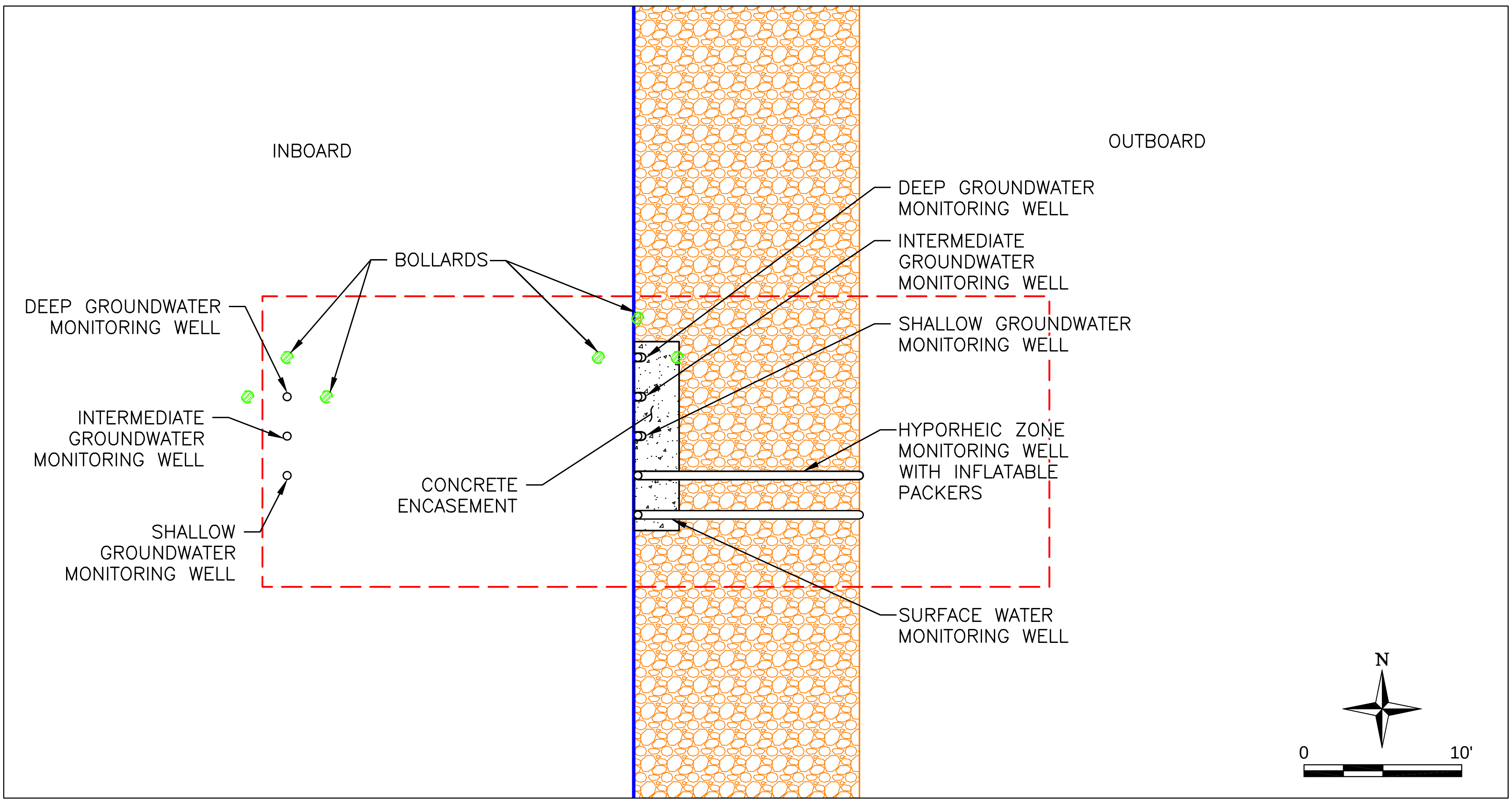
FIGURE 1

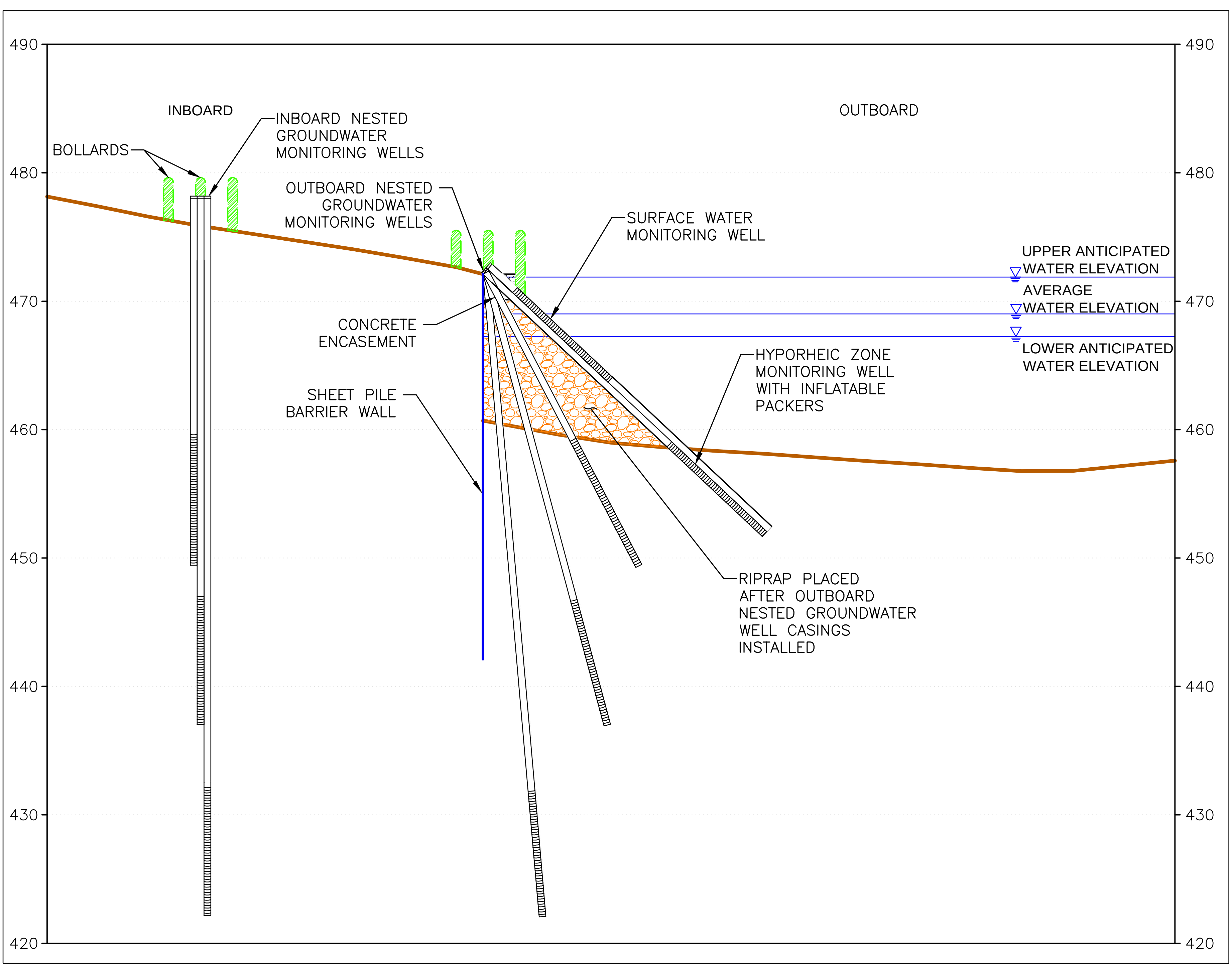
PROPOSED MONITORING NETWORK

SHEET PILE BARRIER ALONG GREAT MIAMI RIVER
PERFORMANCE MONITORING PLAN
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Drawn By: JGP	Checked By: REP	Scale: 1" = 150'	Date: 12/4/07	File: 500MONITORINGNETWORK



A **TYPICAL PLAN**
SCALE 1" = 10'



B **TYPICAL PROFILE**
SCALE 1" = 10'

0 10'

EXPLANATION

- RIP RAP
- CONCRETE
- GROUND / RIVER BED SURFACE
- SHEET PILE BARRIER

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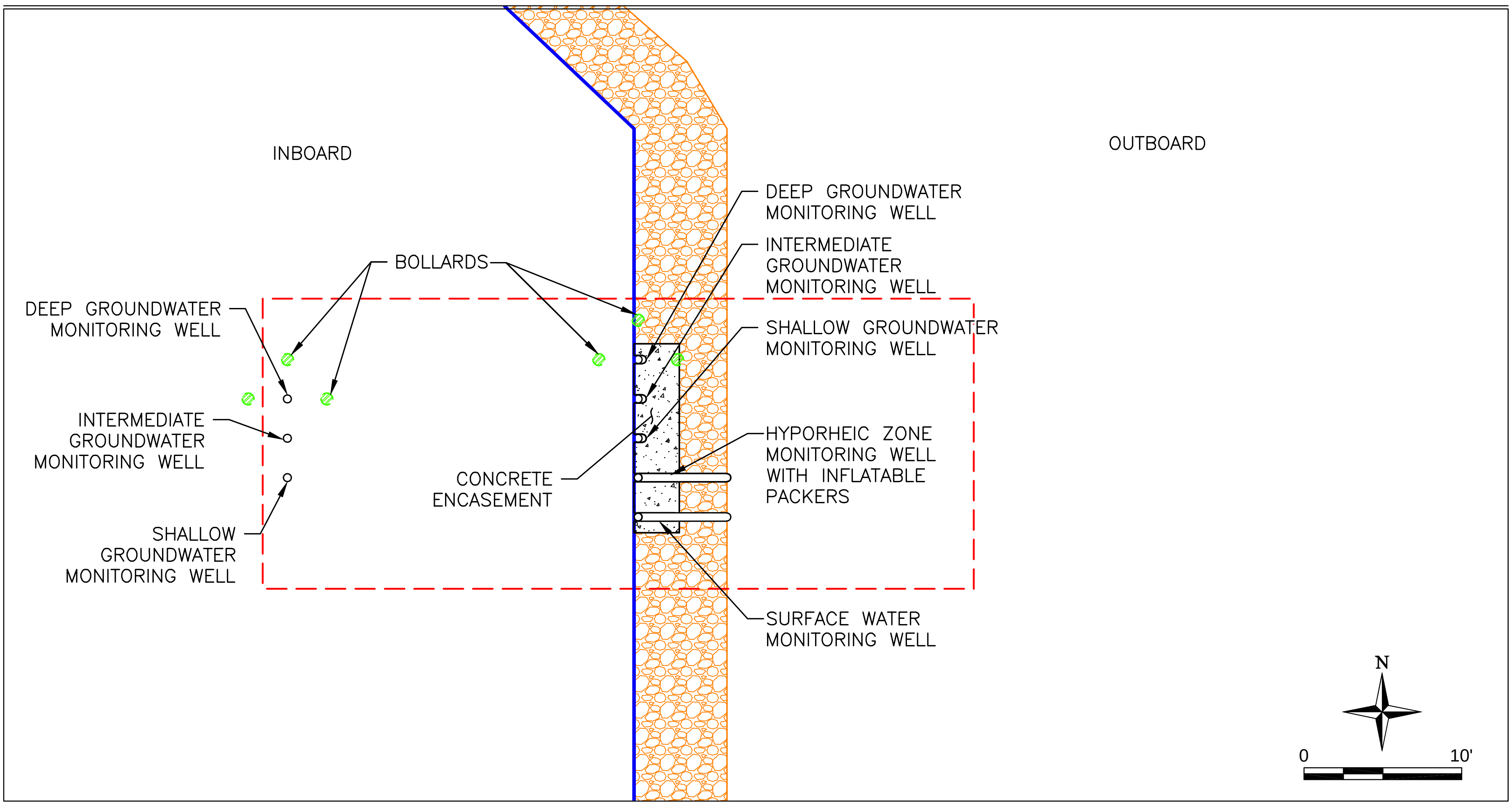
FIGURE 2

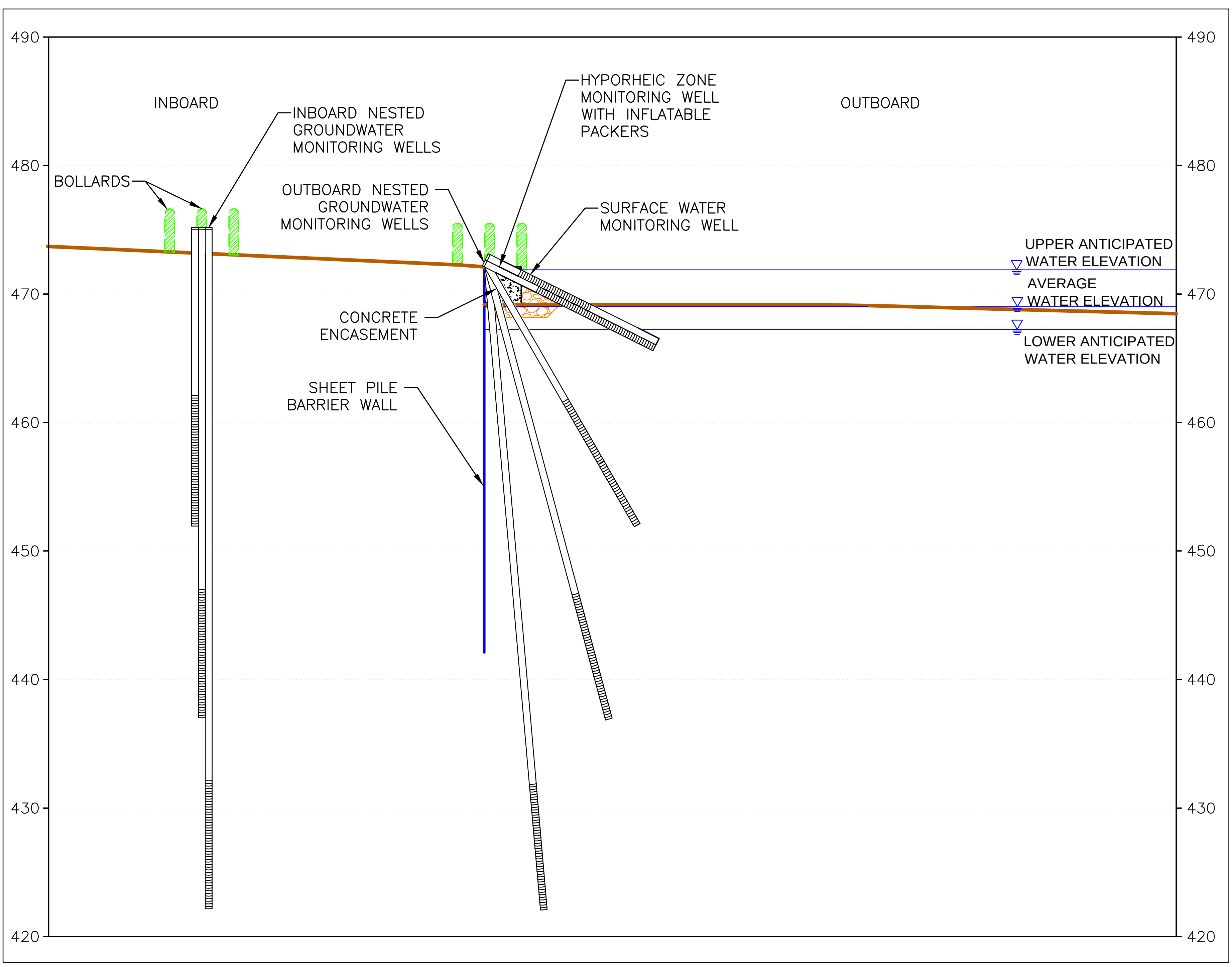
TYPICAL MONITORING CLUSTER SCHEMATIC FOR STEEP GRADE RECONFIGURED BANK

SHEET PILE BARRIER ALONG GREAT MIAMI RIVER PERFORMANCE MONITORING PLAN CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Drawn By: JGP	Checked By: REP	Scale: 1" = 10'	Date: 12/4/07	File: 500MONITORINGNETWORK



A TYPICAL PLAN
SCALE 1" = 10'



EXPLANATION

- RIP RAP
- CONCRETE
- GROUND / RIVER BED SURFACE
- SHEET PILE BARRIER

B TYPICAL PROFILE
SCALE 1" = 10'

0 10'

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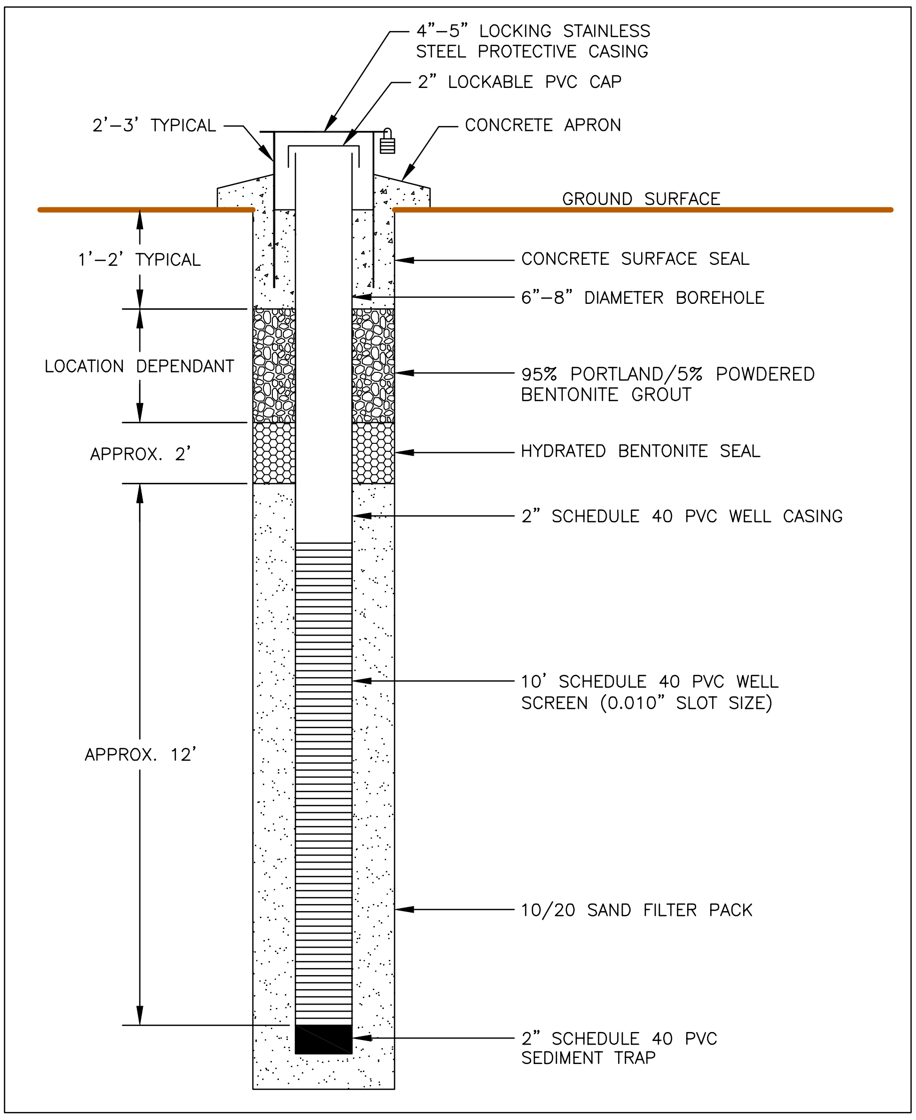
FIGURE 3

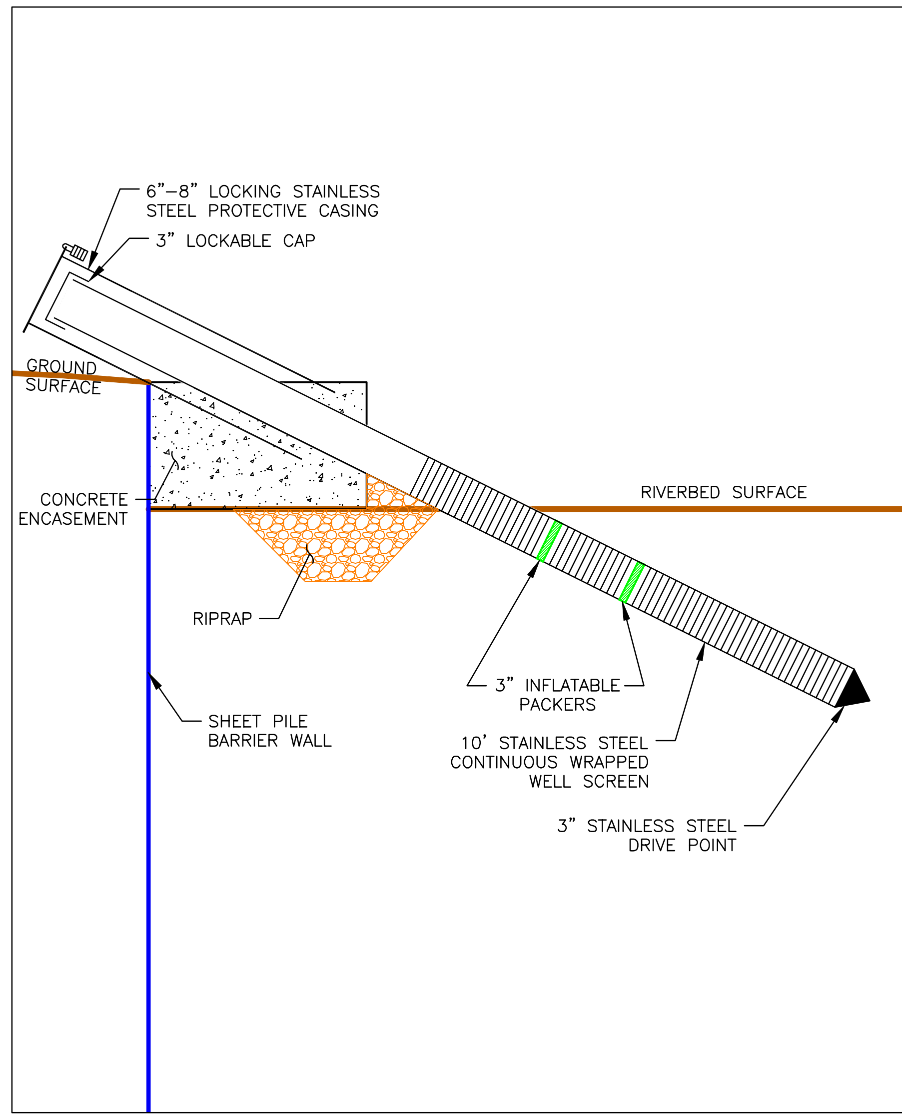
TYPICAL MONITORING CLUSTER SCHEMATIC FOR SHALLOW GRADE RECONFIGURED BANK

SHEET PILE BARRIER ALONG GREAT MIAMI RIVER PERFORMANCE MONITORING PLAN CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

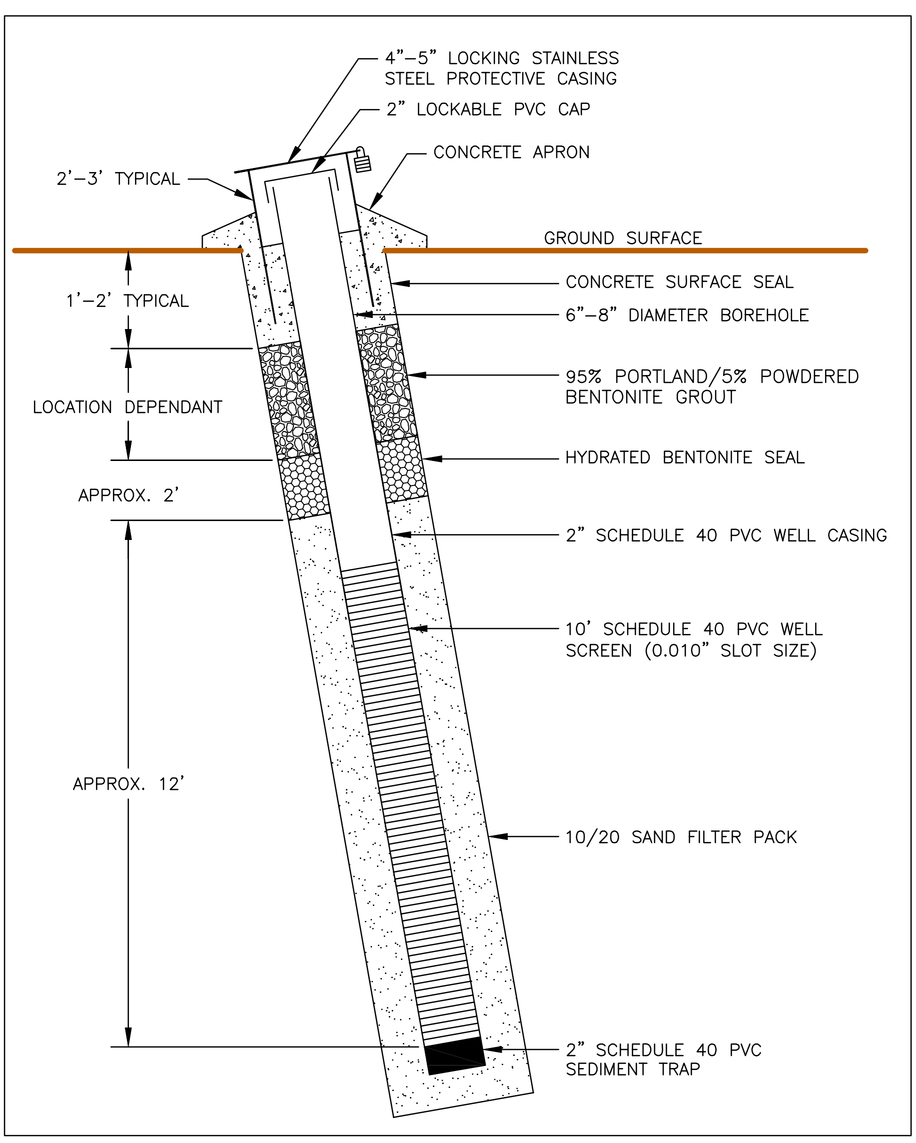
Drawn By: JGP	Checked By: REP	Scale: 1" = 150'	Date: 12/4/07	File: 500MONITORINGNETWORK



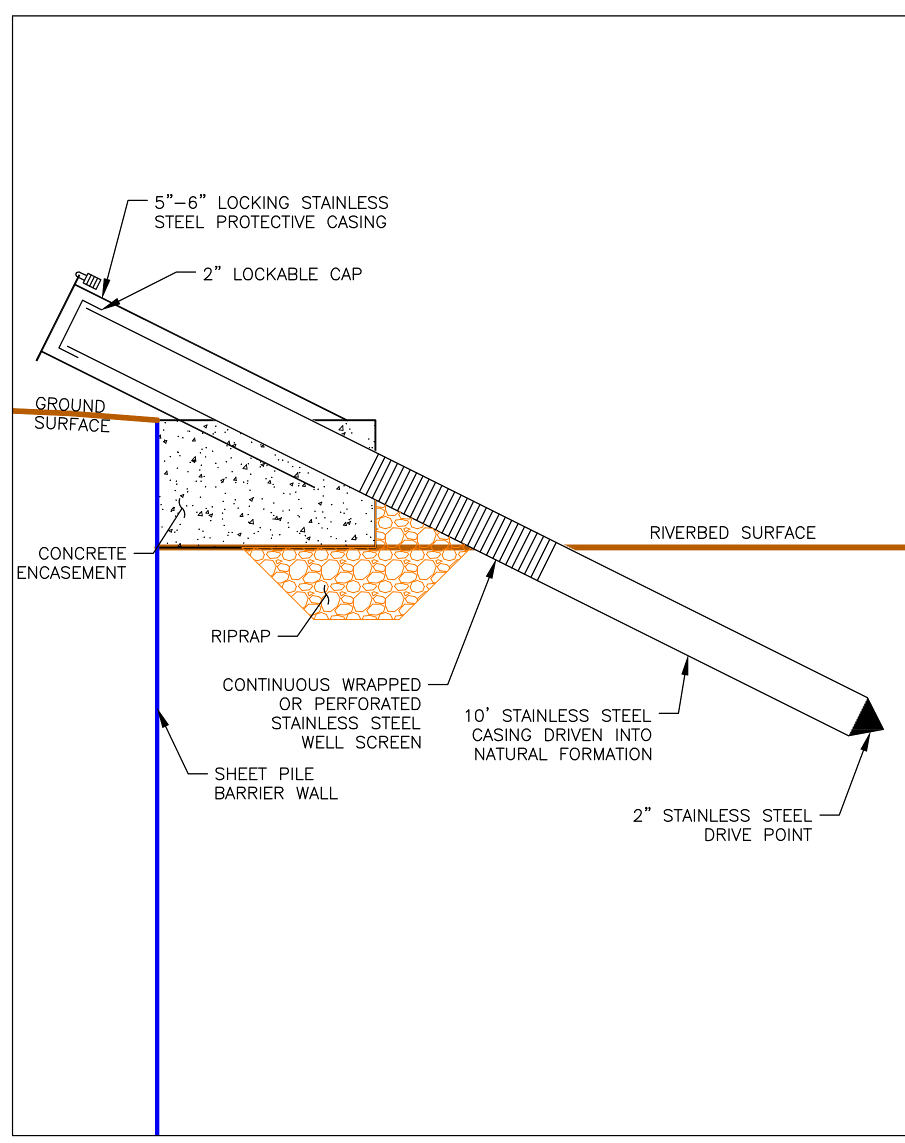
A **TYPICAL VERTICAL GROUNDWATER MONITORING WELL DETAIL**
NOT TO SCALE



B **TYPICAL HYPORHEIC WELL DETAIL**
NOT TO SCALE



C **TYPICAL ANGLED GROUNDWATER MONITORING WELL DETAIL**
NOT TO SCALE



D **TYPICAL SURFACE WATER WELL DETAIL**
NOT TO SCALE

EXPLANATION

- RIP RAP
- CONCRETE
- GROUND / RIVER BED SURFACE
- SHEET PILE BARRIER

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FIGURE 4

TYPICAL MONITORING WELL CONSTRUCTION DETAILS

SHEET PILE BARRIER ALONG GREAT MIAMI RIVER
PERFORMANCE MONITORING PLAN
CHEVRON CINCINNATI FACILITY, HOOVEN, OHIO

Drawn By: JGP	Checked By: REP	Scale: NO SCALE	Date: 12/4/07	File: 500MONITORINGNETWORK