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DIRECT PUSH WELL INNOVATIVE TECHNOLOGY EVALUATION REPORT FOR SOLID WASTE MANAGEMENT UNIT 15 BUILDING 191 NS MAYPORT FL

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ICON ENVIRONMENTAL SERVICES

DIRECT-PUSH WELL (DPW)
INNOVATIVE TECHNOLOGY EVALUATION REPORT

ADDITIONAL ASSESSMENT USING
INNOVATIVE TECHNOLOGY / METHODOLOGY
AT THE
SWMU 15 AND BUILDING 191 AREA
NAVSTA MAYPORT, FLORIDA

Contract No. N47408-96-C-7246

Prepared For:

NAVAL FACILITIES ENGINEERING SERVICE CENTER (NFESC)
PORT HUENEME, CALIFORNIA

Prepared by:

ICON
ENVIRONMENTAL SERVICES

6160 Perkins Road, Suite 100, Baton Rouge, Louisiana 70808 (504) 769-2073 fax (504) 761-4489

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EXECUTIVE SUMMARY

ICON evaluated two sites at the Naval Station Mayport (NAVSTA), Florida as part of an Innovative Technology demonstration project under the Navy Environmental Leadership Program (NELP) program. The Building 191 Area is an active warehouse facility with historical Tetrachloroethene (PCE) groundwater impacts. Solid Waste Management Unit (SWMU) 15, is listed in the HSWA permit as requiring a RCRA Facility Investigation (RFI) for pesticide impact (Benzene hexachloride and Arsenic). ICON Environmental Services, Inc. (ICON) was retained by the US Department of the Navy to implement delineation of groundwater impacts at each site using innovative technology.

ICON developed direct-push well (DPW) technology incorporating small-diameter PVC permanent monitoring wells, and characterization of geology and groundwater bearing zones using borehole geophysical logging equipment modified for shallow geological environments. The logging equipment was capable of through-casing or open-hole logging. Integral to the design of the technology is the ability to use locally available standard drilling equipment for implementation.

The technology was implemented at each site as follows:

- Lithology was characterized by a full suite of geophysical logs in fluid-filled open boreholes drilled immediately outside the area of suspected impact. These logs indicated clay rich zones, groundwater occurrence, and allowed correlation between borings.
- Next, lithology was further characterized within the area of suspected impact by logging natural gamma through sealed driven steel casing. Logs were correlated in the field.
- DPWs were installed by driving sealed steel casing (drive assembly) with a PVC screen encased within (outer screen), to the top of the target zone (determined from geophysical logs); and pushing or hammering the outer screen 6.5 feet into the zone of interest. An inner screen of smaller diameter was then lowered through the steel drive casing and into the outer screen. A Teflon packer sealed the inner screen to the top of the outer screen, and prevented grout from entering the screen. Grout was added, as the drive assembly was withdrawn.
- Conventional wells were installed adjacent to selected DPWs at identical screened intervals to evaluate the technology.

The geophysical logs exhibited excellent correlation to core samples at each site. SWMU 15 is underlain by river/marsh sediments with considerably more clay as compared to Building 191, which is underlain by very dense beach sands and thin carbonate reefs, and three continuous clay layers.

Three sets of twinned DPW/conventional wells were installed for technology evaluation at Building 191. One set of twinned DPW/conventional well was installed at SWMU 15. Laboratory results for DPWs were approximately 20% to 30% higher as compared to samples concurrently acquired from adjacent conventional wells. However, results of resampling the same DPW or conventional well within a four-month period resulted in differences of approximately 50%. Laboratory and/or sampling variability was higher than variability between DPWs and the conventional wells.

Field-measured groundwater turbidity was evaluated because the DPWs rely on development of native soils for a filter pack. The maximum observed difference in turbidity in twinned DPW/conventional wells was 3 NTU. Most DPWs yielded samples less than 14 NTU, with a few higher readings in DPWs installed in carbonate/shell zones.

The difference in field-measured groundwater specific conductance readings in twinned DPW/conventional wells was within 6.5%. The lateral and vertical distribution of Specific Conductance correlated exceptionally well to geology and resistivity response on geophysical logs.

Hydraulic head in twinned DPW/conventional wells were within 0.03 feet NVGD, with the exception of the twinned wells at SWMU 15 where a difference of 0.2 feet was observed. Anomalously high pH and low hydraulic conductivity of the conventional well at that location suggests that grout invasion into the well screen may be the cause of the low hydraulic head.

The actual volume of grout used was compared to the calculated annular volume at each DPW. At SWMU 15, actual use was 1.5 to 3.5 times the calculated annular volume, and was 1.05 to 2.6 times the calculated volume at Building 191. This suggests that an excellent seal was installed.

Hydraulic conductivity testing was conducted in twinned DPW/conventional wells. The Bouwer and Rice method of data evaluation yielded hydraulic conductivity values for DPWs 20% to 50% lower as compared to conventional wells. Drawdown data of the DPWs lacked the characteristic filter sand drainage curve inflection commonly observed in conventional well data, allowing a more reliable curve pick for calculations.

The implementation was successful, even in very dense sands (>200 blows/foot). One DPW in 18 installed at SWMU 15 was replaced, because the inner screen and riser slipped up during retraction of the drive assembly; and one DPW in 24 was replaced at Building 191 because of damage to the drive cone in very dense sands. Damage to each DPW was apparent upon pumping, allowing the wells to be immediately replaced. One conventional well at SWMU 15 exhibited data suggesting grout impact in the screen, evident after the drilling rig had departed the site.

Costs were evaluated for materials, labor and equipment for installation, and are dependent on the site-specific geology. Costs at Building 191 for were 55% less for shallow DPWs, and 76% less for deeper DPWs. If the site had been highly contaminated, estimated costs indicate 80% less for shallow DPWs, and 90.5% less for deeper DPWs. Costs at SWMU 15 for shallow DPWs were 46% less, and for deep DPWs were 72% less than conventional wells. If the site had been highly contaminated, estimated costs indicate 73% less for shallow DPWs and 86% less for deep DPWs.

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SECTION 1

INTRODUCTION

1.0 INTRODUCTION

1.1 INTRODUCTION

Two sites at the Naval Station Mayport (NAVSTA), Florida reported soil and groundwater contamination, and were categorized as eligible for an Innovative Technology demonstration project under the Navy Environmental Leadership Program (NELP) program. Each site has had a complete delineation of shallow soil impact requiring no further soil assessment. Each site had confirmed groundwater impact, requiring further investigation to define horizontal and vertical extent of groundwater impact. ICON Environmental Services, Inc. (ICON) was retained by the US Department of the Navy to implement delineation of groundwater impacts at each site using innovative technology.

1.2 STATEMENT OF THE PROBLEM

Contamination assessments require knowledge of subsurface geology (water bearing zones and confining clay layers); a means to sample groundwater, preferably through permanent wells that allow measurement of contaminant levels through time, and a means to evaluate changes in groundwater flow patterns. Current industry-standard methods of achieving these goals are expensive, and currently popular alternative techniques fail to adequately address all aspects of the assessment. A discussion of the limitations with current industry-standard techniques follows.

1.2.1 INDUSTRY-STANDARD METHODS OF LITHOLOGICAL IDENTIFICATION

Defining subsurface geology is currently accomplished by several different techniques including standard drilling and coring, direct push coring, and direct-push probes that obtain indirect measurements of soil or groundwater properties. Conventional drilling methods include hollow stem augering and rotary wash drilling in which the borehole is sampled using a coring device (split spoon, Shelby tube, core barrel, etc.) to retrieve a sample. The borehole diameter is drilled out through the previously sampled interval to allow for acquisition of the next, deeper undisturbed core sample. Conventional drilling and coring is relatively expensive due to equipment type, number of required laborers, time for core acquisition, waste generation and disposal, and worker exposure to hazardous material.

Direct push methods consist of push coring a soil sample immediately below the pushed open borehole. This system relies on the driving assembly to maintain an open borehole when repeating the sampling procedure (Geoprobe™/Cone Penetrometer Soil Sampling). Generally the cost is comparatively less than conventional methodologies due to lower labor force requirements and worker exposure to hazardous material. If an in-situ media is highly contaminated with non-aqueous phase liquids (NAPL), contaminants may descend downhole during retraction of the drive assembly as the borehole is advanced, increasing worker exposure to hazardous material and cross-contaminating discrete soil samples.

Cone penetrometer testing (CPT) techniques often incorporate additional measurements while pushing such as tip resistance (soil strength), conductivity, infrared emission, etc. The technique is commonly used for geotechnical testing in relation to structural engineering for foundation design. The measuring devices are at the lower end of the drive assembly and are transmitted to the surface data recorder by wire harnesses housed through the drive assembly during pushing. An additional trip must be made to the base of the borehole for proper abandonment via installing a filler media. Also a borehole reading cannot be repeated for verification of the previously obtained data (QA/QC) without pushing another borehole adjacent to the first, otherwise increasing the cost.

Commonly, soil types such as dense sands or refusal on lithified or rock refusal are encountered, which CPT and push core units cannot penetrate. In such environments conventional methodologies (drilling the boreholes) would be the only method of completing the task.

1.2.2 INDUSTRY-STANDARD METHODS OF WELL INSTALLATION

Conventional methods of installing permanent monitoring wells include standard drilling with construction of a well within a borehole, and direct push of pre-packed wells. Conventional methods consist of hollow stem augering or rotary wash drilling a borehole, and constructing the well using filter sand in the screened interval, a bentonite seal above the sand pack, and cement/bentonite grout to ground surface. This industry-standard conventional well installation method is associated with the following:

- A considerable volume of drill cuttings that need to be sampled and analyzed, and disposed at considerable cost if contaminated,
- Substantial disturbance of the groundwater bearing zone by borehole wall smearing in clayey soils (hollow stem augering technique), substantial fluid infiltration into the formation as well as substantial borehole fluid mixing (rotary washing technique) and a substantial volume of the sand pack installed,
- Potential cross contamination when drilling through shallower contaminated zones into uncontaminated lower zones, even when isolation casing is used,
- Poor well construction in areas of heaving sand in which sand flows up into the base of the augers before a well can be set in place as well as the sand pack,
- A substantial volume of well development and purge water that needs to be containerized, sampled and potentially disposed if contaminated,
- Potential for worker exposure to contamination in highly impacted environments, particularly when augers are withdrawn and soil cuttings are directly handled or contaminants mixing into the drilling fluids during circulation,
- and finally, a substantial cost and time requirement as compared to direct push techniques.

Recently direct-push permanent well installation techniques have been developed that rely principally on a "push and retract" mechanism for exposing the well point screen to the aquifer for sampling. Geoprobe ™ has developed such well installation techniques and is implemented with a standard hammer and hydraulics included with the systems. The push and retract permanent well technology involves pushing a drive point to a desired depth and installing pre-packed screens (sand pack) with the riser pipe inside the drive casing. The drive casing is then retracted exposing the prepacked screen to insitu soils. A bentonite slurry is then added to the top of the screen during retraction and grouted as the drive casing is retracted. Potential disadvantages of this push and retract methodology include:

- The borehole outside diameter created is generally larger than the prepacked screen deployed creating a space for possible contaminants from above to infiltrate into the screen interval,
- contamination is often carried down by the drive assembly when pushing through highly contaminated zones into zones that have not been impacted, yielding a positively biased groundwater sampling result,
- During insertion of the drive assembly the driving force (hammer) may not be sufficient to allow penetration of sands > 30 blows/foot (very dense) or the hydraulic pull back may not be

capable of retracting the drive assembly after penetrating dense sands in which case a drill rig would need to be mobilized on site to overdrill any stuck drive assembly.

- A bentonite seal is required to be installed above the screen to eliminate cross communication from water zones or contaminants from up hole (above the screen interval),
- Subsurface lithology can only be obtained from a sampled hole previously drilled or pushed and retracted which increases the cost and worker exposure to contaminants.
- and finally, the density of some soils may not allow a drive assembly to vertically penetrate using the hammering force of the system in which a drilling rig would need to be mobilized to the site to complete the monitor well installation, increasing the project costs.

In the early 1990's ICON personnel developed a push-push groundwater sampling tool that minimized cross-contamination from "carry-down", was reliable to implement, and could be operated with locally available standard drilling rigs. Subsurface lithology was defined using borehole geophysical logging at selected areas around a contaminated area. The method was granted US Patent No. 5,168,765, and was used extensively for contamination assessments. ICON refined this technique to incorporate installation of a permanent well using push-push technology, to allow for confirmation sampling or periodic sampling for temporal trends. The application of this innovative technology is the subject of this evaluation report

1.3 OVERVIEW OF INNOVATIVE TECHNOLOGY

The direct-push well (DPW) technology includes two key components: the DPW drive assembly and well with associated completion materials; and borehole geophysical logging equipment modified for shallow geological environments capable of through-casing or open hole logging. The geophysical logs indicate subsurface stratigraphy and the exact target depth for installation of the DPW, and allow for cost effective vertical profiling of groundwater bearing zones with high precision and accuracy using nested wells.

Integral to the design of the technology is the ability to use locally available standard drilling equipment for implementation. For this project, ICON selected a Gus Pech drilling rig with a mud pump for rotary drilling, and an air compressor for air hammering. Therefore, the rig could accomplish the following tasks in a single mobilization:

- Define subsurface geology (aquifers and confining zones) by conventional methods (hollow stem auger with soil coring, and mud rotary drilling with soil coring); and by geophysical logging fluid filled open boreholes,
- Additional geological characterization by geophysical logging (natural gamma) through sealed pushed or hammered drive pipe,
- Installation of direct push wells (DPWs),
- And installation of conventional monitoring wells, by hollow stem auger (for shallow wells and for installation of surface casing of deep wells) or mud rotary (for deep wells through isolation casing).

The method can be utilized at any location, dependant only on drilling rig availability. Additionally, if hard rock refusal or dense soil is encountered (eliminating use of all direct push techniques) the drilling rig can still complete the assessment using conventional drilling techniques in the same mobilization.

1.3.1 DPW DRIVE ASSEMBLY AND WELL CONSTRUCTION

The method includes use of a sealed steel drive tube with a sacrificial sealed tip that is driven to within five feet of the desired screened interval (See Figure 1-1). Driving is facilitated using a standard drilling rig by pushing with the rig hydraulics (Photo No.2), or hammering with a downhole air hammer driven by an air compressor supplied on drilling rig (Photo No. 10). Inside the sealed drive tube is a 5-foot long 1.25-inch diameter PVC screen with 0.008-inch factory slots, and a 2-foot upper blank riser pipe (outer screen, Photo No.1). Once the desired depth is reached, the screen is hammered out six an one-half feet below the bottom of the drive pipe into the groundwater zone to be sampled, thereby placing 1.5 foot blank riser pipe directly against native soils (Photo No. 4). A 3/4-inch diameter Schedule 40-PVC well with flush-coupled threaded joints and 5 feet of 0.01-inch slot screen is then lowered through the drive pipe, and into the 1.25-inch screen to the bottom of the sump (Photo No.5).

A Teflon packer seal is pre-installed around the 3/4 inch PVC riser pipe approximately 1.5 foot above the screen and seals the 3/4-inch well pipe to the top of the 1.25 inch screen to prevent grout from entering the annulus of the inner and outer screen sections (Photo No.5). The annular space between the 3/4-inch diameter PVC riser pipe and the steel drive casing is filled with grout (Photo No.6), and the riser pipe is held in place as the drive casing is withdrawn from the hole (Photo No.7). The grout slurry is therefore placed under the vacuum pressure caused by the drive casing retrieval, and extends from the Teflon packer up to ground surface. A 3/4-inch diameter monitoring well is therefore constructed with a five-foot long screen at a discrete depth with proper grout to surface (Photo No. 8).

1.3.2 GEOPHYSICAL LOGGING

Subsurface lithology is characterized using two applications of geophysical logging: logging at the perimeter of an area of interest (outside the contaminated area) in open fluid-filled boreholes for definition of lithology and groundwater bearing zones; and logging within the area of interest through steel casing to correlate the lateral and vertical extent of lithological units defined at the perimeter.

1.3.2.1 Perimeter Logging

A borehole is rotary washed to the desired depth and geophysical logging tools are lowered through the borehole. Multiple gamma ray, single-point-resistance, resistivity, spontaneous potential and caliper logs are run in the borehole to obtain detailed occurrences of soil types, soil changes (vertical and lateral), groundwater occurrence and some degree of groundwater quality. Furthermore, caliper logs are acquired to measure borehole changes in diameter in order to correct any of the logs erroneous responses due to borehole diameter fluctuation (common in rotary washed boreholes). Soil cores should be obtained continuously from a minimum of one geophysically logged borehole to identify and correlate soil types to log responses.

1.3.2.2 Logging in the Area of Concern

The steel casing with an expendable tip is pushed to the desired depth (i.e. through multiple zones) and a small diameter (1.375 inch) natural gamma logging tool is lowered through the drive casing on a wireline and natural gamma is recorded. Gamma ray logs exhibit distinct signatures for a given zone in addition to delineating soil bed boundaries, and are correlated between logged boreholes. The gamma ray logs are correlated to the perimeter logs to define the lateral and vertical changes of soil distribution and groundwater bearing zones, to precisely place the screen of the DPW clusters at each location (defining areas of contamination).

1.4 FIELD TEST SITE DESCRIPTION

The two sites at Naval Station Mayport include: Building 191 Area, an active warehouse facility with tetrachloroethene (PCE) groundwater impacts; and Solid Waste Management Unit (SWMU) 15, listed in the HSWA permit as requiring a RCRA Facility Investigation (RFI) for pesticide impact (benzene hexachloride and arsenic). The history and characteristics of each site is briefly discussed.

1.4.1 BUILDING 191 AREA

A contamination assessment was conducted in 1994, for the release of diesel fuel from underground piping associated with an aboveground storage tank located on the south side of Building 191. Tetrachloroethene (PCE) was detected in one of the wells on the north site of the building. A groundwater assessment targeting PCE was conducted in May 1995. The assessment included the installation of several monitoring wells installed using conventional hollow stem auger techniques. PCE was confirmed in two wells at concentrations of 26 ug/L and 100 ug/L (73 ug/L in a duplicate). Trichloroethene (TCE) was also detected in the same wells at concentrations of 9 ug/L and 10 ug/L (8 ug/L in a duplicate).

Subsurface lithology, as determined from environmental borings and from geotechnical borings conducted at Building 191 for foundation design revealed the following stratigraphy, listed in order of occurrence from ground surface:

Thickness (ft)	Description (density - std penetration test)
6 to 11 ft (surface)	Loose Fine Sand, with Clay, Silt and Shell Frags, (≈5 - 20 blows/ft)
25 - 50 ft	Firm to Very Dense gray Fine Sand (30 - 70 blows/ft)
8 ft	Locally Within Dense Sand (above), ≈ 30 ft bls (≈5 blows/ft)

Groundwater occurs at water table conditions at an average depth of 4.5 feet below land surface.

1.4.2 SWMU 15

Pesticides and application equipment were stored in a covered shed east of Building 48A during 1963 and 1964. As a result of probable washing and rinsing activities, area soils and groundwater exhibit impact from pesticides. An initial investigation of SWMU 15 was conducted in 1993, and additional sampling was conducted in 1994.

Surface soil samples were acquired and the following compounds were detected: 4-4'-DDE, 4,4'-DDT, Chlordane, Heptachlor, and Heptachlor epoxide; additionally, Arsenic and Beryllium were detected at concentrations that exceeded benchmark concentrations. Shallow soil sample data indicated that shallow pesticide impact occurs in numerous "hot spots" at the surface, with minimal downward migration.

Groundwater was sampled utilizing six monitoring wells installed using conventional hollow-stem auger techniques. Pesticides were detected in two of the wells, including alpha-, beta- , and gamma-benzene hexachloride (BHC). Arsenic and Sodium were also detected at levels above benchmark and background screening concentrations.

Subsurface lithology, as determined from log of boring diagrams associated with the monitoring wells, reveal the following stratigraphy listed in order of occurrence from ground surface:

Thickness (ft)	Description (density - std penetration test)
12 to 15 ft (surface)	Sand and Silty Sand Dredge Fill, (≈13 - 25 blows/ft)
0.5 - 2 ft	Sandy Clay, Clay, gray-green (≈2 - 5 blows/ft)
20 ft	Silty Sand with Clay lenses (≈5 - 25 blows/ft)

It should be noted that sampling occurred using split spoon samplers at 5-ft intervals, with average of 50% recovery. Therefore, less than 50% of the subsurface profile was identified.

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Groundwater occurred at shallow depths, generally within 4 feet below land surface.

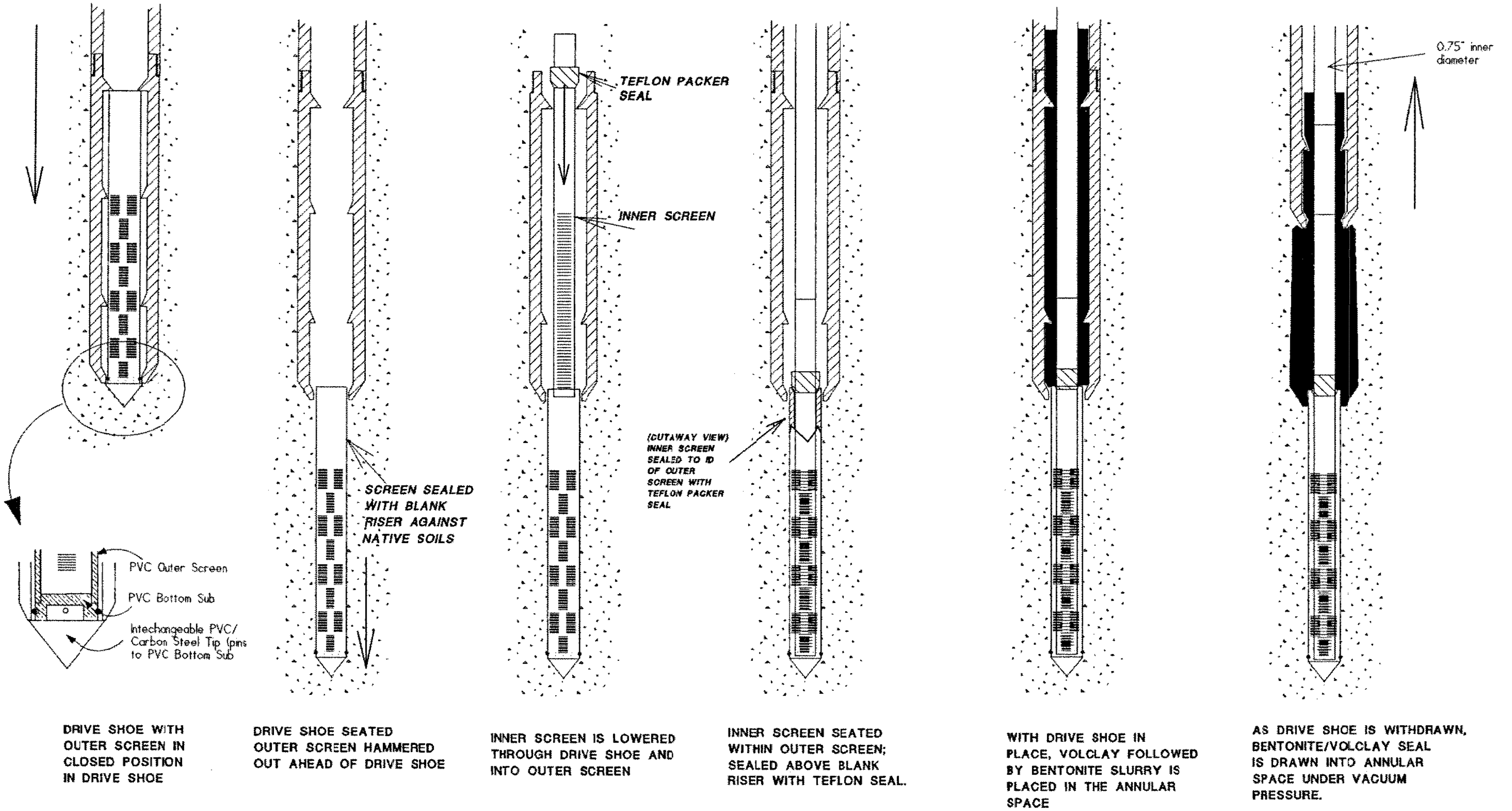

Figure 1-1

DIRECT PUSH WELL INSTALLATION AND DRIVE ASSEMBLY SCHEMATIC
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY
SWMU 15 AND BUILDING 191 AREA
NAVSTA MAYPORT, FLORIDA

ICON ENVIRONMENTAL SERVICES
6160 Perkins Road, Suite 100, Baton Rouge, LA 70808

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SECTION 2

PROJECT DESIGN

2.0 PROJECT DESIGN

2.1 PROJECT OVERVIEW

The overall objectives of the project were twofold: 1) the horizontal and vertical delineation of groundwater impact using technically defensible groundwater sample results; and 2) the innovative technology demonstration including data to evaluate the operating range of the technique, the precision of the sampling technique, and the relative cost of the technique.

The following tasks were conducted at both of the project sites:

- Detailed vertical characterization of subsurface geology, using modified borehole geophysical logging equipment; the primary objectives were to determine the lateral extent of low-permeability sediments within the thick permeable zones previously identified at the sites;
- Installation of direct-push monitoring wells, throughout the area of concern. These wells were vertically stratified to ensure horizontal and vertical delineation of groundwater impact;
- Installation of conventionally-installed monitoring wells adjacent to selected direct-push wells, to allow comparison to the conventional installation;
- Groundwater sampling and aquifer testing of direct-push wells, existing wells, and new conventionally installed wells.

The two sites at Naval Station Mayport, Florida include: Building 191 Area, the site of verified Tetrachloroethene (PCE) impact to groundwater; and Solid Waste Management Unit (SWMU) 15, listed in the HSWA permit as requiring a RCRA Facility Investigation (RFI) for pesticide impact (Benzene hexachloride and Arsenic).

The project objectives (horizontal and vertical delineation of groundwater impact, and innovative technology demonstration) were addressed at each site as follows:

- Two perimeter boreholes were drilled at SWMU 15 and Building 191 to a depth of approximately 65 feet using rotary wash drilling technique (Figure 2-1and 2-2). Layne Environmental Drilling provided drilling services using a Gus Pech drilling rig with a 5" x 6" mud pump. These perimeter borings were geophysical logged for acquisition of the following geophysical logs: natural gamma (calibrated to API standard), natural gamma (counts per second), spontaneous potential (SP), single point resistance, and 6" normal resistivity. Several existing monitoring wells at SWMU 15 were logged through casing using natural gamma.

- During the initial phase of the project (April and May 1997), direct-push wells (DPWs) were installed, fifteen at Building 191 and seventeen at SWMU 15. Direct push wells were nested, with two or more screened intervals (depths) at one location. DPW driving was accomplished by either direct pushing with rig hydraulics in combination with the weight of the drill rig (Gus Pech) or by hammering with a downhole air hammer supplied by the air compressor installed on the drill rig. All DPWs were completed with flush-grade surface completions, and were developed by pumping with a peristaltic pump. Upon receipt of the lab results from the initial phase of the project, our contract was modified to include nine additional DPWs at Building 191 to further delineate the groundwater plume, and one additional DPW at SWMU 15. These additional DPWs and the conventional wells were installed in August and September 1997.
- Three conventional monitoring wells twinned adjacent to DPWs at each site were originally planned; however, upon evaluation of preliminary results, Navy personnel requested that two of the conventional monitoring wells at SWMU 15 be installed as stand-alone wells to provide additional lateral data on Arsenic concentrations. The conventional wells were installed using the hollow-stem auger drilling technique, and soil samples were acquired for lithology using split spoon samplers. Conventional wells were constructed with a five foot screened interval, adjacent to DPWs with the same screened interval (if twinned). Some of the conventional wells installed below the first groundwater zone included isolation casing to minimize potential carry down. The conventional wells provided samples and aquifer test data that the direct-push well samples can be compared to in order to assess the precision of the innovative technology.
- ICON conducted sampling and head measurements of direct push wells, and all existing monitoring wells. Groundwater samples were sent to Quality Analytical Laboratories (QAL, CH_2M Hill Labs), a Navy-approved subcontracted offsite analytical laboratory. Falling head insitu tests were conducted in twinned DPWs and adjacent conventional wells, and data was evaluated for comparative analysis.

2.2.3 HOLLOW STEM AUGERING AND WELL INSTALLATION

Conventional wells were installed using the hollow-stem auger technique. Soil borings were advanced using 4.25-inch inside diameter (I.D.) hollow stem augers. Soil samples were acquired using split barrel samplers. A standard penetration test (SPT), following the guidance of American Society for Testing Materials (ASTM-D1586-84) was performed each time the soil sampler was advanced. The blow counts were recorded and used to identify relative changes in the density of material at each sample interval. This information was useful in comparing the boring logs to historical construction borings at Building 191. The site geologist supervising and directing soil boring activities described soil samples.

Upon reaching total depth, a monitoring well was installed in each boring. The wells consisted of 2-inch diameter Schedule 40 PVC pipe with a 5-foot long commercially fabricated, threaded, flush joint PVC screen with 0.01-inch slots. A filter pack consisting of 20/40 silica sand was placed to approximately 2 feet above the top of the screen. Filter pack was placed to approximately 1 foot above the top of the screen in the shallow wells, to allow for a proper seal. A 2-foot bentonite seal was installed above the filter pack; a 1-foot bentonite seal was used in the shallow wells. The bentonite seal was allowed to hydrate for a minimum of 8 hours prior to grout placement. A non-shrinking cement-bentonite grout was placed above the seal to ground surface, unless shallow screen placement precluded grout placement. The cement-bentonite mixture consisted of the following compounds in proportion:

- 94 pounds of neat Type II Portland Cement
- Not more than 4 pounds of 100 percent sodium bentonite powder
- Not more than 7 gallons of potable water

A flush-grade surface completion was installed consisting of an 8-inch diameter (or equivalent) well box with bolt down gasket cover, and a water-tight well cap. The well box included a cement shroud sloped to prevent ponding over the well. The wells were developed by pumping with a decontaminated 2-inch diameter Grundfos pump.

The location of each well, ground surface and top of casing elevation was determined by Holland & Bassett Professional Land Surveyors, Jacksonville, Florida.

2.2.4 WELL SAMPLING AND TESTING

All existing monitoring wells at each site were sampled concurrent with sampling of the DPWs during the March/April 1997 field event. Selected DPWs and existing wells were resampled, and the recently installed conventional wells were sampled during the August/September 1997 field event. Sampling was conducted using low-flow purging and sampling procedures. A peristaltic pump was used for purging and sampling. Field measured parameters included pH, Specific Conductance, temperature, and turbidity. Target analytes at the Building 191 area included Chlorinated Halocarbons as per EPA Method 8010. Target analytes at SWMU 15 included Pesticides as per EPA Method 8080, and Arsenic as per Method SW846 7060 (GFAA).

The potentiometric surface was determined at each site on a minimum of two separate dates using an electronic water elevation detector.

Insitu hydraulic conductivity testing was conducted in several DPWs and adjacent conventional wells at each site. A falling head test was conducted in selected DPWs by pouring a known volume of well water into the well and measuring the rate of water level decline using a Druck 50 psi 0.63-inch diameter pressure transducer and a Hermit Data Logger. Rising head and falling head tests were also conducted in selected conventional monitoring wells. Rising head tests were conducted by bailing a known volume of water from the well, and monitoring the recharge rate. The pressure transducer was placed near the bottom of the well. Data was entered into a computer program, and time-drawdown curves were generated. Data was evaluated using the Bouwer and Rice Method (*WWR, June 1976; Groundwater V27, No. 3, June 1989*).

2.2.5 QUALITY CONTROL AND DATA EVALUATION

The precision of the sampling and laboratory analysis was evaluated using two duplicate samples per site (two samples collected independently at a sampling location during a single act of sampling). This resulted in an average of one duplicate sample per every 10 samples.

The accuracy of the sampling technique was evaluated using equipment blanks (clean reagent water collected from pumping through precleaned dedicated tubing to determine whether the sampling equipment was introducing bias). Two equipment blanks were acquired per site. A peristaltic pump was allowed to pump through pre-cleaned dedicated tubing into the sample container or a clean vessel.

Trip Blanks, another indicator of sample accuracy, function as an indictor of possible contamination during transit to and from the laboratory. One trip blank was prepared by the laboratory and placed in a cooler designated for shipping of volatile organic compounds, and accompanied the samples at all times.

Laboratory results were validated as per guidance in the USEPA CLP National Functional Guidelines for Organic Data Review, Multi-Media Multi-Concentration and Low Concentration Water (December 1994)

2.3 TECHNOLOGY EVALUATION CRITERIA

The success of the innovative technology is evaluated in following sections of this report by:

1. Comparison to results from adjacent conventional monitoring well. Comparisons include agreement of hydraulic head, hydraulic conductivity testing using bail/slug testing, and relative percent difference between groundwater sample results.
2. Ease of installation as compared to density of soils. Many borings at Building 191 conducted for foundation design included standard penetration testing, delineating several dense zones. Field logs of direct-push well installations are compared to density of subsurface soils to estimate the range of utility of the technology.
3. Cost comparisons with conventional well installations. These account for materials, labor, and time requirements for installation, development, and sampling; and disposition of purge and development water. Comparisons are exclusive of planning and report preparation, and analytical costs.
4. Integrity of installations. Hydraulic head and groundwater contaminant distribution in vertically nested well clusters is evaluated for evidence of potential cross-contamination. The grout integrity of the DPWs is evaluated by comparing the borehole volume to the actual grout volume used.

Supporting documentation (lab results, field sampling sheets, etc.) is included in *the Final Contamination Assessment Report, SWMU 15 and Building 191 Area, Additional Assessment Using Innovative Technology, NAVSTA Mayport, Florida, ICON, February 1997.*

SECTION 3

GROUNDWATER CHEMISTRY EVALUATION

3.0 GROUNDWATER CHEMISTRY EVALUATION

Groundwater at both sites was sampled by purging with a peristaltic pump using the EPA Low-Flow Groundwater Sampling Procedures (*Puls and Barcelona, EPA ORD, April 1996*). Dedicated Teflon downhole tubing was placed in each DPW. Indicator parameters were considered to be stabilized when pH variation was less than 0.2 SU, temperature variation less than 1°F, conductivity variation less than 10 percent, and turbidity variation less than 10%. A target turbidity level of less than 5 NTU was attempted prior to sampling. Field equipment was calibrated three times daily and adjusted for drift, as necessary. Laboratory analyses was provided by Quality Analytical Laboratories, Inc. (QAL), Montgomery, Al or Redding, CA. Samples were placed in laboratory-supplied containers, chilled at 4°C in ice chests, and shipped to the laboratory under strict chain-of-custody documentation.

Laboratory data were validated using guidance in *National Functional Guidelines for Organic Data Review, Multi-Media, Multi-Concentration and Low Concentration Water, EPA/540/R/94/090.*

3.1 LABORATORY ANALYSES

3.1.1 BUILDING 191

Locations of existing monitoring wells, DPWs, and recently installed conventional wells can be found on Figure 3-1. Because of the low concentration and sporadic detection of target analytes, approximate areas of contaminant occurrence in each zone are indicated as hatched zones on Figure 3-1. Wells were purged at a flow rate less than 100 mls/min with a peristaltic pump, and groundwater sampling was conducted by capping the top of the dedicated Teflon tubing with a gloved finger, and lifting the finger to allow water to slowly fill two 40-ml VOA vials. Laboratory analysis included Purgeable Halocarbons using EPA Method SW-846, Method 8010 (modified). A summary of field and laboratory results is included in Table 3-1. To exhibit the vertical distribution of groundwater impact, laboratory results are presented on cross-section diagrams in Figures 3-2 and 3-3.

Note that the well designations *s,i,d* refer only to the relative screened depth at a particular well cluster, and do not indicate an absolute depth of the screened interval. Because of this, discrete groundwater bearing zones have been designated as *Zone A* through *Zone C* in this report.

In general, the highest concentration (160 to 980 ug/L) of purgeable halocarbons consisted of Tetrachloroethene (PCE) and Trichloroethene (TCE), detected in one small area north of Building 191 in the twinned wells DPW2d / MW07d, both screened at the base of Zone A. All parameters were non-detect (<1 ug/L) in the mid and upper portion of Zone A at the same location (DPW2s & DPW2d). The compound cis-1,2-Dichloroethene was also detected in the twinned wells DPW2d/MW07d, at concentrations of 75 to 150 ug/L. This compound is frequently cited as a degradation compound of PCE under reducing groundwater conditions, and was also detected at low concentrations (less than 6 ug/L) in DPWs to the west screened at the base of Zone A, and in Zones B and C (Figures 3-1 and 3-3). Other compounds detected at low concentrations (23 ug/L or less), generally to the west and southwest of DPW2d included 1,1-Dichloroethane and 1,1-Dichloroethene.

Another detected compound that appears to be unrelated to those previously cited was Chloroform, sporadically detected at low concentrations (less than 3.1 ug/L) in top- and mid-Zone A at DPW4, and at the base of Zone A at the DPW8 cluster.

Results of twinned DPW-Conventional wells screened at identical vertical intervals for the September 1997 sampling event are as follows:

Parameter (ug/L)	DPW2d	MW7d	RPD (%)	DPW8s	MW8s	RPD (%)	DPW8i	MW8i	RPD (%)[1]
Tetrachloroethene	200/280[2]	160	20/43	nd	nd	0	<1.0	1.4	28
Trichloroethene	950/980[2]	610	36/38	1.2	<1	16	<1.0	1.0	0
Chloroform	nd	Nd	0	nd	nd	0	<1.0	2.0	.5
1,1-Dichloroethane	nd	Nd	0	nd	nd	0	14	<1	93
cis-1,2-Dichlorethene	150/150[2]	75	50	nd	nd	0	nd	nd	0

1 - detection limit used in calculating %RPD; 2 - two results indicate the sample and its blind duplicate.

The highest discrepancy was noted for 1,1-Dichloroethane in the twinned wells DPW8i/MW8i screened at the base of Zone A, a poorly sorted sand with shell fragments and clayey zones. In general, the analytical results of DPW groundwater samples were slightly higher as compared to conventional well groundwater samples. The relative percent difference between DPWs and adjacent conventional wells may be biased either higher or lower because of variability of the sampling and/or laboratory protocol.

Samples from DPW2d were first acquired in May 1997, when the well was installed. The adjacent conventional well MW07d was installed and sampled in September 1997, and well DPW2d was concurrently resampled. Assuming no appreciable plume movement or dilution (because the suspected source of impact occurred in the early 1950's, none is expected within this six month period), the difference between the May and September analytical results indicates sampling and/or laboratory bias. A comparison of the results is as follows:

Parameter (ug/L)	May 1997 Results - DPW2d	September 1997 Results - DPW2d	September 1997 Results - DPW2d dupl.	RPD (%) May/Sept	RPD (%) Sept dupl.
Tetrachloroethene	240	200	280	17	29
Trichloroethene	470	950	980	50	3
cis-1,2-Dichlorethene	<1	150	150	99	34

In general, results of the DPW samples were approximately 20 - 30 % higher as compared to samples from conventional wells. Results of resampling the same DPW (May - September events) yielded differences of approximately 50%; and results of blind duplicate analysis during the same sampling event of the same DPW yielded an average difference of 22%. Laboratory variability was clearly higher than the variability between DPWs and conventional wells.

3.1.2 SWMU 15

Wells were purged using low-flow micropurging with a Peristaltic pump, and groundwater samples were collected by plumbing the dedicated tubing into a glass drop-out vessel, and creating a vacuum in the drop out vessel by pumping with a peristaltic pump. Laboratory analysis of samples from SWMU 15 included Organochlorine Pesticides (EPA Method 8080) and Arsenic (Method 7060, GFAA). Locations of existing monitoring wells, DPWs, and recently installed conventional wells can be found on Figure 3-4. The plan view distribution of arsenic, the most prevalent target analyte detected at the site, is included in Figure 3-4 as isopleth contours. A cross section diagram exhibiting arsenic concentrations is included as Figure 3-5. A summary of field and laboratory results is included in Table 3-2.

One set of twinned DPW-Conventional wells screened at identical vertical intervals was installed for comparative analysis. All target analytes were non-detect in samples from each of the twinned wells.

3.2 FIELD TURBIDITY

Because the DPW wells rely two graded well screens (0.008 inch slot for the outer, and 0.01 inch slot for the inner), and development in native sediments to form a filter pack, turbidity was measured in the field during sampling using an Orbeco Hellage Model 966 digital turbidity meter. Field turbidity values and visual observation notes are included on Tables 3-1 and 3-2.

3.2.1 BUILDING 191

Building 191 sediments are comprised of approximately 25 feet of poorly sorted very fine to medium grained sands with shell fragments and two 4-inch thick worm and shell reefs (Zone A), and lower intervals of sand/clay sequences approximately five feet in thickness (Zones B and C).

In general, turbidity values were clear, exhibiting readings of 12 nephelometric turbidity units (NTU) or less. The exceptions included DPW5i with a reading of 22 NTU, and DPW9s with a reading of 41 NTU. Both wells yielded water samples that were a milky white in appearance, and is believed to result from copious quantities of shell material in the aquifer matrix in that area. Additionally, well DPW9i yielded yellow water with a high TDS content (from field measured specific conductance and correlated to resistivity logs) with a reading of 25 NTU.

A comparison of field turbidity from twinned DPW/conventional wells is as follows:

Parameter (NTU)	DPW2d (May 97)	DPW2d (Sep 97)	MW7d (Sep 97)	RPD (%)	DPW8s	MW8s	RPD (%)	DPW8i	MW8i	RPD (%)
Field turbidity	3	5	2	60	2	2.9	31	5	5	0

Although significant differences in turbidity were noted in comparisons of twinned DPW/conventional wells, all samples available for comparison were below the target 10 NTU.

3.2.2 SWMU 15

Subsurface sediments at SWMU 15 consist of layered clays and fine silty and/or clayey sands, grading to a cleaner more massive sand to the north. This site exhibits considerably more clay as compared to Building 191 area.

In general, all wells yielded samples that exhibited readings that were 14 NTU or less. One sample from DPW1d yielded a sample of 16.7 NTU, in water that was yellow with a reduced odor and high TDS content (field specific conductance and correlation to low resistivity readings in the geophysical logs). Turbidity data from one pair of twinned DPW/conventional wells was obtained: both wells yielded samples exhibiting turbidity of 5 NTU.

3.3 FIELD SPECIFIC CONDUCTANCE

Because of the relatively low and sporadic detection of target analytes at both sites, a review of specific conductance is helpful to illustrate the validity of geophysical logging and DPW well technology. Both sites consist of sediments that were deposited in a nearshore environment, either dense beach sands with little clay (Building 191), or tidal-influenced marsh sediments with appreciable clay content (SWMU 15 area). Zones of high specific conductance groundwater (probably poorly flushed connate water) were observed at each site. Field measured Specific Conductance and field appearance are included on Tables 3-1 and 3-2.

3.3.1 BUILDING 191

Groundwater specific conductance values are presented in cross section diagrams adjacent to the well screen in Figure 3-6 and 3-7. Figure 3-6 exhibits a zone of high specific conductance in Zone B and C. This is supported by the geophysical logs of B-1 and B-2 (Figure 3-6) that exhibit low resistivity in those zones indicating a highly conductive zone (high TDS/salinity).

The clay layers between Zones A, B and C are locally effective in isolating pockets of connate water of differing conductivity. The specific conductance readings correlate well with interpreted geology: the conductivity of Zone B near DPW2 decreases as the overlying clay layer pinches out to the west, merging with low conductivity groundwater from Zone A (Figure 3-6); and similarly the conductivity of Zones B and C decreases as the two zones merge into low conductivity groundwater of Zone A at DPW7 (Figure 3-7).

All conductivity readings exhibit a spatial relationship that correlates well; no anomalous readings were observed. This is further indirect evidence of the representativeness of the groundwater samples from discretely screened DPWs. A comparison of specific conductance in twinned wells is as follows:

Parameter (uS/cm)	DPW2d (May 97)	DPW2d (Sep 97)	MW7d (Sep 97)	RPD (%)	DPW8s	MW8s	RPD (%)	DPW8i	MW8i	RPD (%)[1]
Specific Conductance	700	655	618	5.6	501	536	6.5	595	629	5.4

The relative percent difference in twinned DPW/conventional wells was very low, indicative of good agreement between the two methods.

3.3.2 SWMU 15

Groundwater specific conductance values are presented in a cross section diagram adjacent to each well screen in Figure 3-8. Figure 3-8 exhibits a zone of high specific conductance in the lower water bearing zones to the south, where considerably more clay sediments are found. Specific conductance values to the north in the same zone are over an order of magnitude lower, suggesting either better flushing or fresh connate water associated with the channel sands in that area. This is supported by the resistivity log at B-1 (Figure 3-8) in which the resistivity curve is suppressed in sand intervals indicating a highly conductive zone (high TDS/salinity), whereas in sand zones at B-2 exhibits lower resistivity, indicates higher specific conductance.

The difference in field measured specific conductance obtained from twinned wells DPW7d / MW7d (1151 uS/cm and 1598 uS/cm, respectively) was 28%. The pH of MW7d was 9.0 as compared to 7.0 for DPW7d, indicating that the conventional well (which was installed through 10 feet of isolation casing and the isolation was grouted and allowed to set overnight) may yield groundwater samples influenced by grout cement.

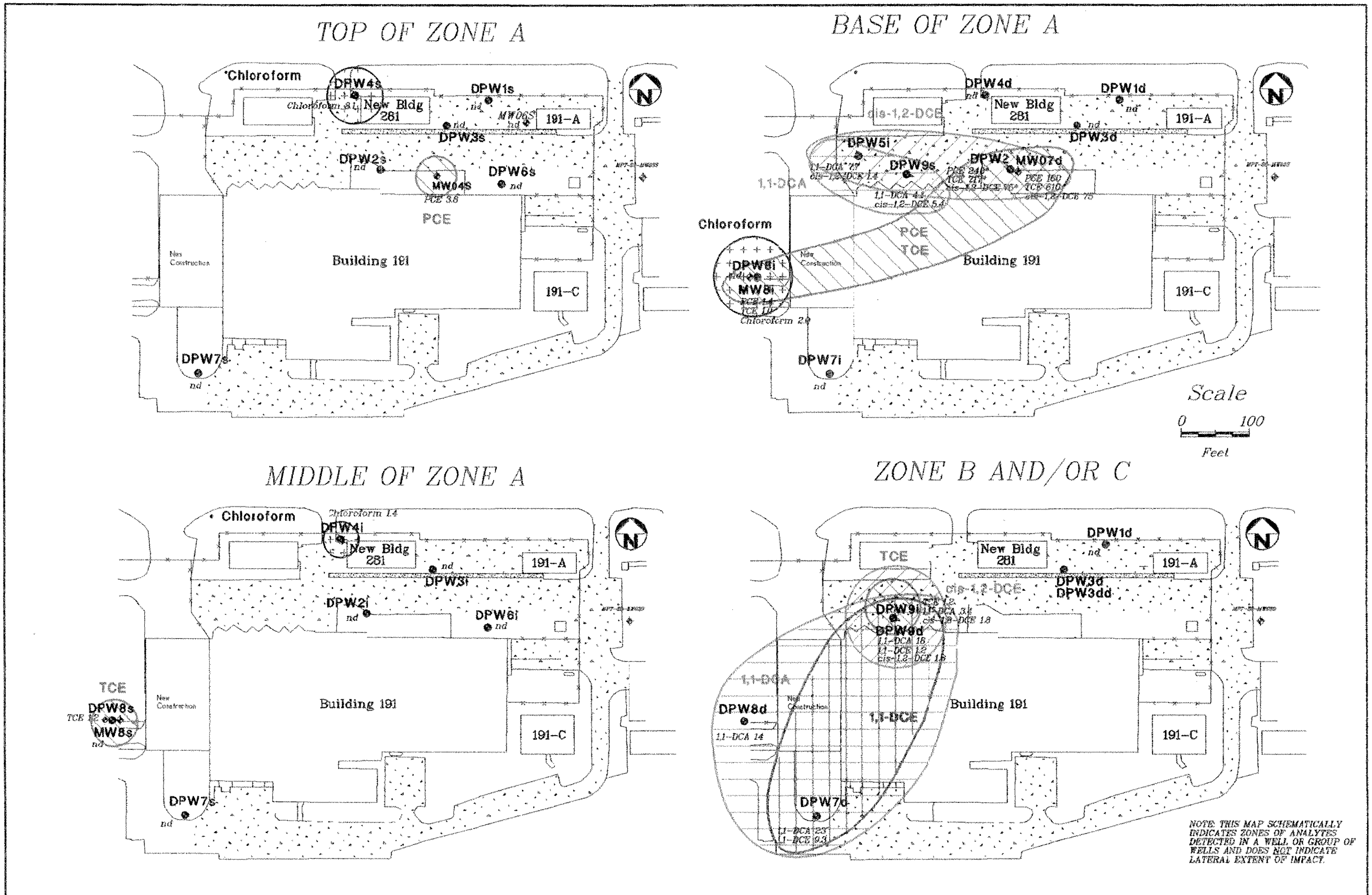

Figure 3-1

BUILDING 191 WELL LOCATIONS WITH ZONES OF DETECTED ANALYTES
NAVSTA MAYPORT, FLORIDA
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY/METHODOLOGY
NAVAL FACILITIES ENGINEERING SERVICE CENTER (NFESC)

ICON ENVIRONMENTAL SERVICES
6160 Perkins Road Suite 100 Baton Rouge, LA 70808
(504) 769-2073 fax (504) 761-4489

File Name: 191-pots.gcd	Date: January 1997
Project Number: 9052-001-0100	Source: NFESC Field Measurement ICON Env. Svcs.; 1996, 1997
Revision Number 0	
File Directory data\navy	
Drawn By Greg Miller	

TABLE 3-1
NAVSTA MAYPORT, FLORIDA
BUILDING 191 AREA
SAMPLING SUMMARY - DETECTED COMPOUNDS

	MW04s	MW06s	DPW1s	DPW1d	DPW2s	DPW2i	DPW2d	DPW2d	MW07d	DPW3s	DPW3i	DPW3d	DPW3dd
Sample Date	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97	9/3/97	9/3/97	5/9/97	5/9/97	5/9/97	5/9/97
Screen Depth (ft bls)													
top	3	2.5	3	36.5	3	17	27	27	27	3	22	35.5	41.5
bottom	13	12.5	8	41.5	8	22	32	32	32	8	27	40.5	46.5
Zone	Top-A	Top-A	Top-A	Zone B	Top-A	Mid-A	Base-A	Base-A	Base-A	Top-A	Mid-A	Zone B	Zone C
Depth to Wtr (5/8/97)	4.12	3.98	3.09	4.88	5.14	5.37	5.38	5.57	5.65	3.37	4.35	4.65	5.38
Develop Volume (gal)	n/a	n/a	7.5	9.3	5	13	13	n/a	110	3.8	4	8.3	7
Purge Volume (gal)	4.2	3.3	0.5	1.8	1.5	1.3	1.4	3	2.7	1.8	1.75	2.8	31
Field Turbidity (ntu)	11.7	2.5	2.1	5	4.2	10.1	3	5	2	1.9	2.9	9.5	2.5
Field PH (std units)	7	7.3	7.8	7.7	7.2	7.8	7.5	7.2	7.1	7.2	7.4	7.5	7.1
Field Cond (uS/cm)	300	500	600	1,800	400	300	700	655	618	600	600	7100	15,400
Field Appearance	Initial Biosolids	red bacteria	clear	clear, slight H_2S odor	clear	clear	clear w/ sl gry color	clear	clear	clear	clear w/ sl gry color	clear	clear
Tetrachloroethene (ug/L)	**3.8**	< 1	< 1	< 1	< 1	< 1	**240**	**200 / 280**	**160**	< 1	< 1	< 1	< 1
Trichloroethene (ug/L)	< 1	< 1	< 1	< 1	< 1	< 1	**470**	**950 / 980**	**610**	< 1	< 1	< 1	< 1
Chloroform (ug/L)	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
1,1-Dichloroethane	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
1,1-Dichloroethene	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
cis-1,2-Dichloroethene	< 1	< 1	< 1	< 1	< 1	< 1	< 1	**150 / 150**	**75**	< 1	< 1	< 1	< 1

2.9/2.9 - denotes sample and blind duplicate result
< 0.6 - less than limit of quantification

TABLE 3-1
NAVSTA MAYPORT, FLORIDA
BUILDING 191 AREA
SAMPLING SUMMARY - DETECTED COMPOUNDS

	DPW4s	DPW4i	DPW4d	DPW5i	DPW6s	DPW6i	DPW7s	DPW7i	DPW7d
Sample Date	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97
Screen Depth (ft bls)									
top	3	17	27.5	27	3.2	22	10	26	43.5
bottom	8	22	32.5	32	8.2	27	15	31	48.5
Zone	Top-A	Mid-A	Base-A	Base-A	Top-A	Mid-A	Mid-A	Base-A	Zone C
Depth to Wtr (ft fm TOC)	4.21	4.19	4.2	4.37	3.53	5.08	5.66	5.82	5.78
Develop Volume (gal)	7.8	8	8.5	13	2.4	5.7	3.5	7	5
Purge Volume (gal)	2.2	1.2	1.7	2.7	1.5	2	3.1	3.3	3.1
Field Turbidity (ntu)	17	4.1	4.2	22	2.2	2.6	9	18	5
Field PH (std units)	7.8	8	7.6	7.4	7.5	7.6	7.5	8.7	7
Field Cond (uS/cm)	200	600	600	700	700	600	420	350	1151
Field Appearance	clear sl gry color	clear	clear	sl turbid, milky white	clear	clear	clear sl yellow	clear sl yellow	clear H_2S odor
Tetrachloroethene (ug/L)	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Trichloroethene (ug/L)	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Chloroform (ug/L)	**3.1**	**1.4**	< 1	< 1	< 1	< 1	< 1	< 1	< 1
1,1-Dichloroethane (ug/L)	< 1	< 1	< 1	7.7	< 1	< 1	< 1	< 1	**23**
1,1-Dichloroethene (ug/L)	< 1	< 1	< 1	**1.4**	< 1	< 1	< 1	< 1	**9.3**
cis-1,2-Dichloroethene	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1

2.9/2.9 - denotes sample and blind duplicate result
< 0.6 - less than limit of quantification

TABLE 3-1
NAVSTA MAYPORT, FLORIDA
BUILDING 191 AREA
SAMPLING SUMMARY - DETECTED COMPOUNDS

	DPW8s	MW08s	DPW8i	MW08i	DPW8d	DPW9s	DPW9i	DPW9d
Sample Date	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97	5/9/97
Screen Depth (ft bls)								
top	10	10	26	26	41	26.5	33	41
bottom	15	15	31	31	46	31.5	38	46
Zone	Mid-A	Mid-A	Base-A	Base-A	Zone C	Base-A	Zone B	Zone C
Depth to Wtr (ft fm TOC)	4.54	4.4	4.5	4.45	4.98	4.08	4.08	4.38
Develop Volume (gal)	6	45	8.5	80	8.9	9	4.5	6.5
Purge Volume (gal)	2.8	2.9	3.3	3.5	3.3	5	4	3.2
Field Turbidity (ntu)	2	2.9	5	5	10	41	25	7
Field PH (std units)	7.2	7	7.1	7.4	7.2	7.5	7.3	7.6
Field Cond (uS/cm)	501	536	595	629	5,550	659	4,990	3,610
Field Appearance	clear	clear, sl yellow	clear	clear	clear	white milky turbidity	yellow	clear
Tetrachloroethene (ug/L)	< 1	< 1	< 1	**1.4**	< 1	< 1	< 1	< 1
Trichloroethene (ug/L)	**1.2**	< 1	< 1	**1.0**	< 1	< 1	**1.2**	< 1
Chloroform (ug/L)	< 1	< 1	< 1	**2.0**	< 1	< 1	< 1	
1,1-Dichloroethane (ug/L)	< 1	< 1	< 1	< 1	**14**	**4.1**	**3.4**	**18**
1,1-Dichloroethene (ug/L)	< 1	< 1	< 1	< 1	< 1	< 1	< 1	**1.2**
cis-1,2-Dichloroethene	< 1	< 1	< 1	< 1	< 1	**5.4**	**1.8**	**1.7**

2.9/2.9 - denotes sample and blind duplicate result
< 0.6 - less than limit of quantification

TABLE 3-2
SWMU 15 SAMPLING SUMMARY - DETECTED COMPOUNDS
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY
NAVSTA MAYPORT, FLORIDA

	MW01s	MW02s	MW03s	MW04s	MW04s	MW05s	MW05i	DPW1s	DPW1i	DPW1d
Sample Date	5/5/97	5/5/97	5/2/97	5/5/97	9/4/97	5/5/97	5/5/97	5/2/97	5/2/97	5/2/97
Screen Depth (ft bls)										
top	5	2	6	5	5	8	25	3.2	10	22
bottom	15	12	16	15	15	18	30	8.2	15	27
Depth to Wtr (ft fm TOC)	5.25	3.49	4.21	4.8	5.84	7.05	7.98	4.15	4.17	7.48
Develop Volume (gal)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	9	17	6
Purge Volume (gal)	3	1.1	2.5	1.3	6	2	2.3	1.5	1	2.2
Field Turbidity (ntu)	14	6.2	13	13.5	3	6.5	5.8	5.7	10.1	16.7
Field PH (std units)	7.8	7.7	8.1	7.8	7.1	7.5	7.4	7.7	7.5	7.5
Field Cond (uS/cm)	400	500	300	400	2920	300	400	500	800	10,700
Field Appearance	Initial Biosolids	clear	clear	clear	sl yellow	clear	Initial biosolids	Clouded during sampling	clear	yellow, H_2S odor
Arsenic (ug/L)	3.5	4.7	1.5	403/407	215	< 0.6	1.6	2.2	1	0.8
beta-BHC (ug/L)	< 0.05	< 0.05	< 0.05	2.9/2.9	3.6	< 0.05	< 0.05	< 0.050	< 0.050	< 0.050
Heptachlor epoxide (ug/L)	< 0.05	< 0.05	< 0.05	0.13/0.13	< 0.30	< 0.05	< 0.05	< 0.050	< 0.050	< 0.050
4,4'-DDE	<0.10	< 0.10	< 0.10	< 0.10 / <0.10	< 0.30	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10

2.9/2.9 - denotes sample and blind duplicate result
< 0.6 - less than limit of quantification

TABLE 3-2
SWMU 15 SAMPLING SUMMARY - DETECTED COMPOUNDS
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY
NAVSTA MAYPORT, FLORIDA

	DPW2s	DPW2d	DPW3s	DPW3i	DPW3d	DPW4s	DPW4i	DPW4d	DPW5s	DPW5i	DPW5d
Sample Date	5/5/97	5/5/97	5/5/97	5/5/97	5/5/97	5/2/97	5/2/97	5/2/97	5/5/97	5/5/97	5/5/97
Screen Depth (ft bls)											
top	3.2	27.5	3.2	10	27	3.2	10	27.5	3	10	27
bottom	8.2	32.5	8.2	15	32	8.3	15	32.5	8	15	32
Depth to Wtr (ft fm TOC)	3.96	6.39	5.1	5.05	7.95	6.12	6.56	7.45	4.47	4.66	7.25
Develop Volume (gal)	2.5	8.5	4	8	5.2	3.5	11	10	8	9	10
Purge Volume (gal)	2	3.2	1.2	1.4	1.5	1	1.2	2.5	1	1.2	1.2
Field Turbidity (ntu)	7.8	11	12	4.5	3.1	1.5	2.5	12.7	14.5	nm	nm
Field PH (std units)	8.4	8.2	7.7	7.2	8	7.8	7.6	9.4	8.1	7.8	8.7
Field Cond (uS/cm)	300	1700	400	1000	1800	300	700	400	500	800	900
Field Appearance	clear, suds	clear	clear	clear, slight H_2S odor	clear, bubble H_2S odor	clear	clear	clear	clear, some bubbles	clear	lower yield
Arsenic (ug/L)	1.6	0.9	0.7 / 0.8	11.6	< 0.6	3.1	1.4	< 0.6	0.8	< 0.6	< 0.6
beta-BHC (ug/L)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Heptachlor epoxide (ug/L)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
4,4'-DDE	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

2.9/2.9 - denotes sample and blind duplicate result
< 0.6 - less than limit of quantification

TABLE 3-2
SWMU 15 SAMPLING SUMMARY - DETECTED COMPOUNDS
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY
NAVSTA MAYPORT, FLORIDA

	DPW6s	DPW6i	DPW6d	DPW7D	MW7D	MW06S	MW08S
Sample Date	5/2/97	5/2/97	5/2/97	9/4/97	9/4/97	9/4/97	9/4/97
Screen Depth (ft bls)							
top	3	10	27.5	23	23	4.5	4.5
bottom	8	15	32.5	28	28	9.5	9.5
Depth to Wtr (ft fm TOC)	5.33	5.19	7.81	8.32	8.7	6.67	5.94
Wtr Elev (ft NVGD)	7.42			3.95	3.75	6.16	5.94
Develop Volume (gal)	9	11	18				
Purge Volume (gal)	0.9	1.5	1	4	3.7	3.7	3.7
Field Turbidity (ntu)	11	3.8	5.7	5	5	5	6
Field PH (std units)	7.5	7	7.5	7	9	7.8	7.6
Field Cond (uS/cm)	500	4400	500	1151	1598	551	455
Field Appearance	clear	yellow, H_2S odor; lower yield	clear	clear, slight H_2S odor	clear	clear	clear
Arsenic (ug/L)	1.7	< 0.6	< 0.6	<5.0	<5.0	81 / 79	< 5.0
beta-BHC (ug/L)	< 0.050	< 0.050	< 0.050	<0.04	<0.04	0.043 / 0.041	< 0.040
Heptachlor epoxide (ug/L)	< 0.050	< 0.050	< 0.050	< 0.02	< 0.02	0.047 / 0.043	< 0.020
4,4'-DDE	<0.10	<0.10	<0.10	<0.020	<0.020	0.044 / 0.040	< 0.020

2.9/2.9 - denotes sample and blind duplicate result
< 0.6 - less than limit of quantification

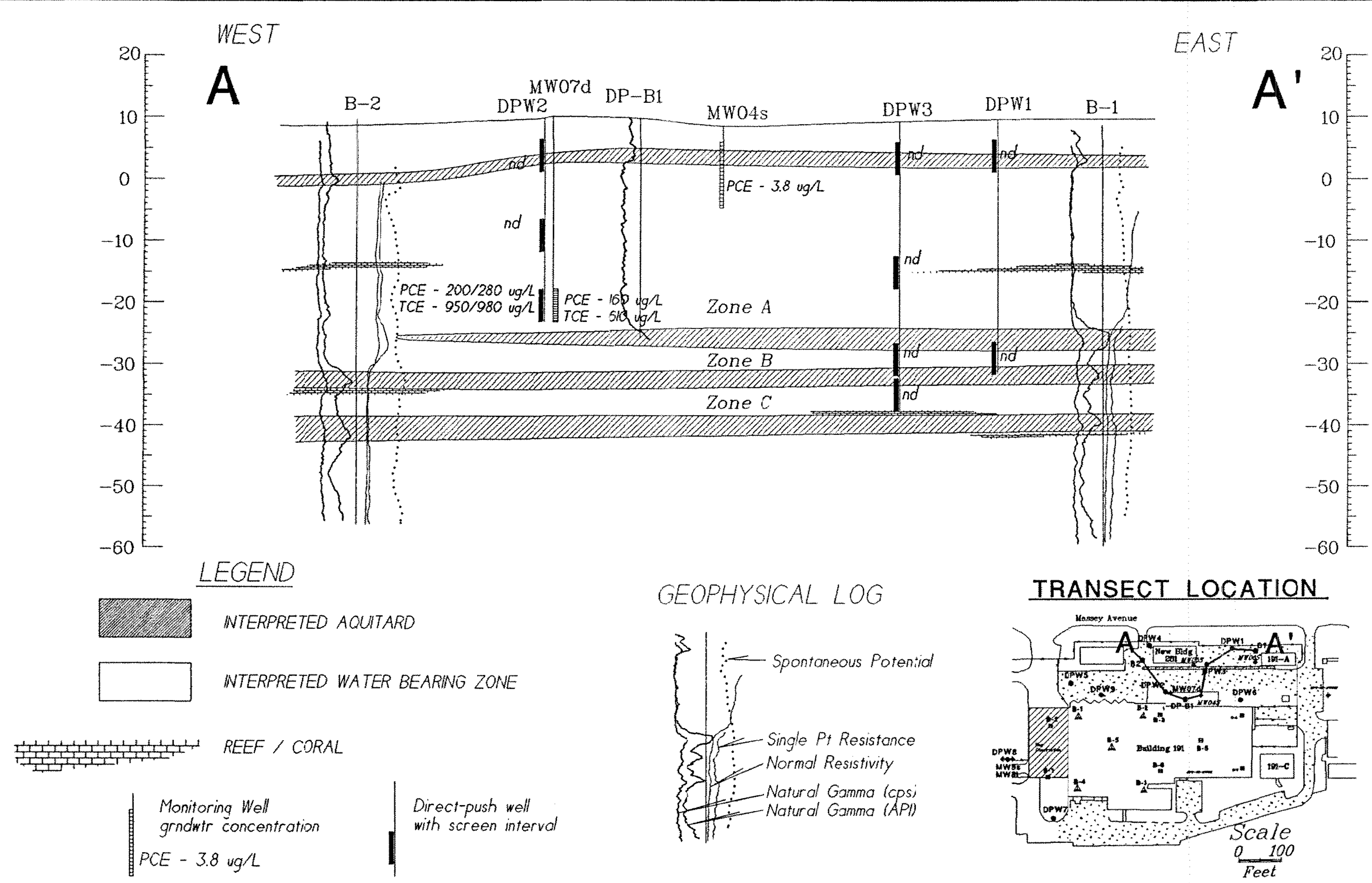

Figure 3-2

EAST-WEST CROSS SECTION DIAGRAM, WITH GROUNDWATER CHLORINATED HALOGEN RESULTS
BUILDING 191 AREA
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY
NAVSTA MAYPORT, FLORIDA

ICON ENVIRONMENTAL SERVICES
5637 Superior Dr. Suite B-1 Baton Rouge, LA 70816

File Name:	Date: 05/23/97
Project Number: 9052-001-0300	Source: Field Measurement ICON Env. Svcs.; 1993; 1996
Revision Number	
File Directory	
Drawn By	

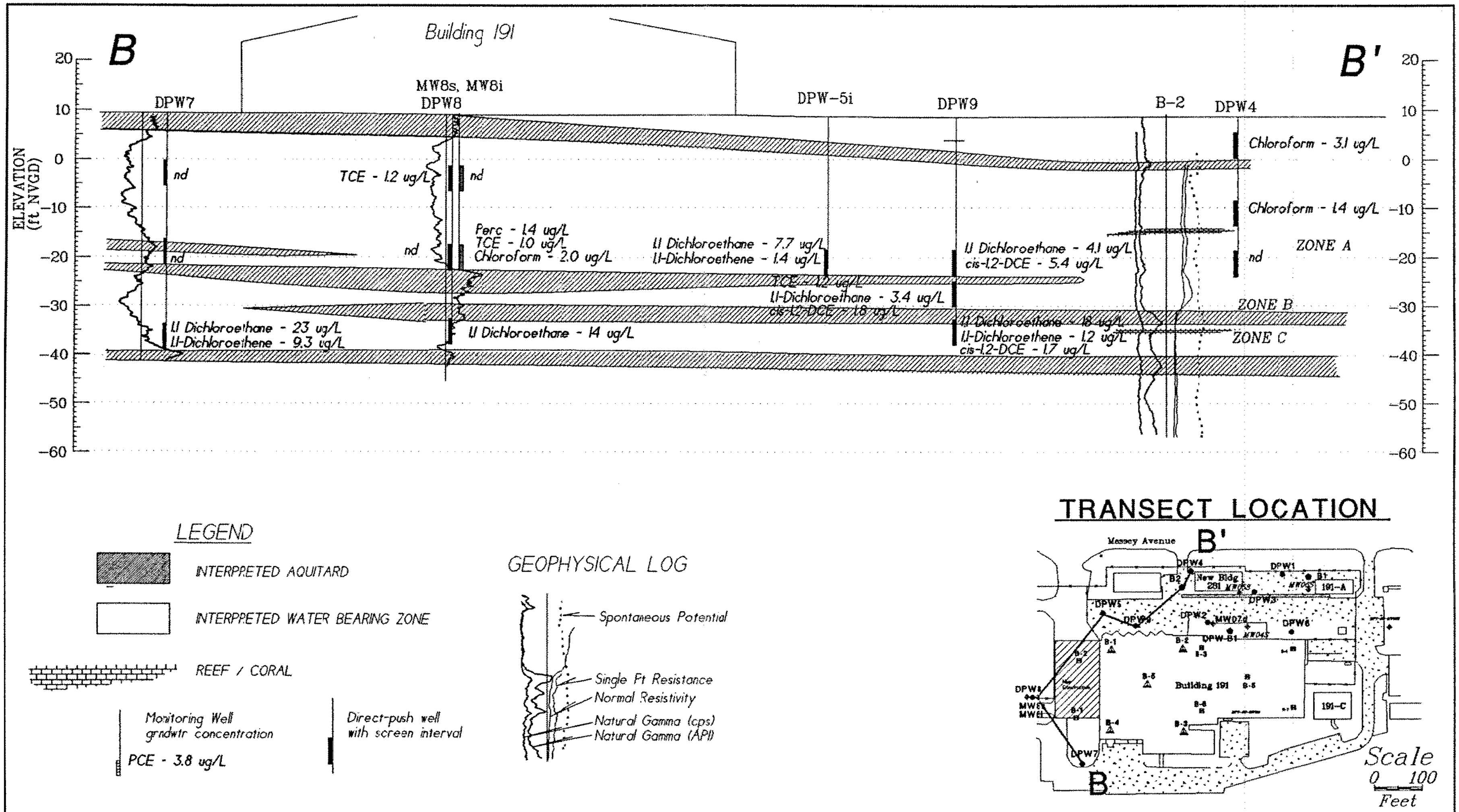

Figure 3-3

NORTH - SOUTH CROSS SECTION DIAGRAM WITH GROUNDWATER CHLORINATED HALOGEN RESULTS
BUILDING 191 AREA
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY
NAVSTA MAYPORT, FLORIDA

ICON ENVIRONMENTAL SERVICES
5637 Superior Dr. Suite B-1 Baton Rouge, LA 70816

File Name:	Date: 05/23/97
Project Number: 9052-001-0300	Source:
Revision Number	Field Measurement
File Directory	ICON Env. Svcs.; 1993; 1996
Drawn By	

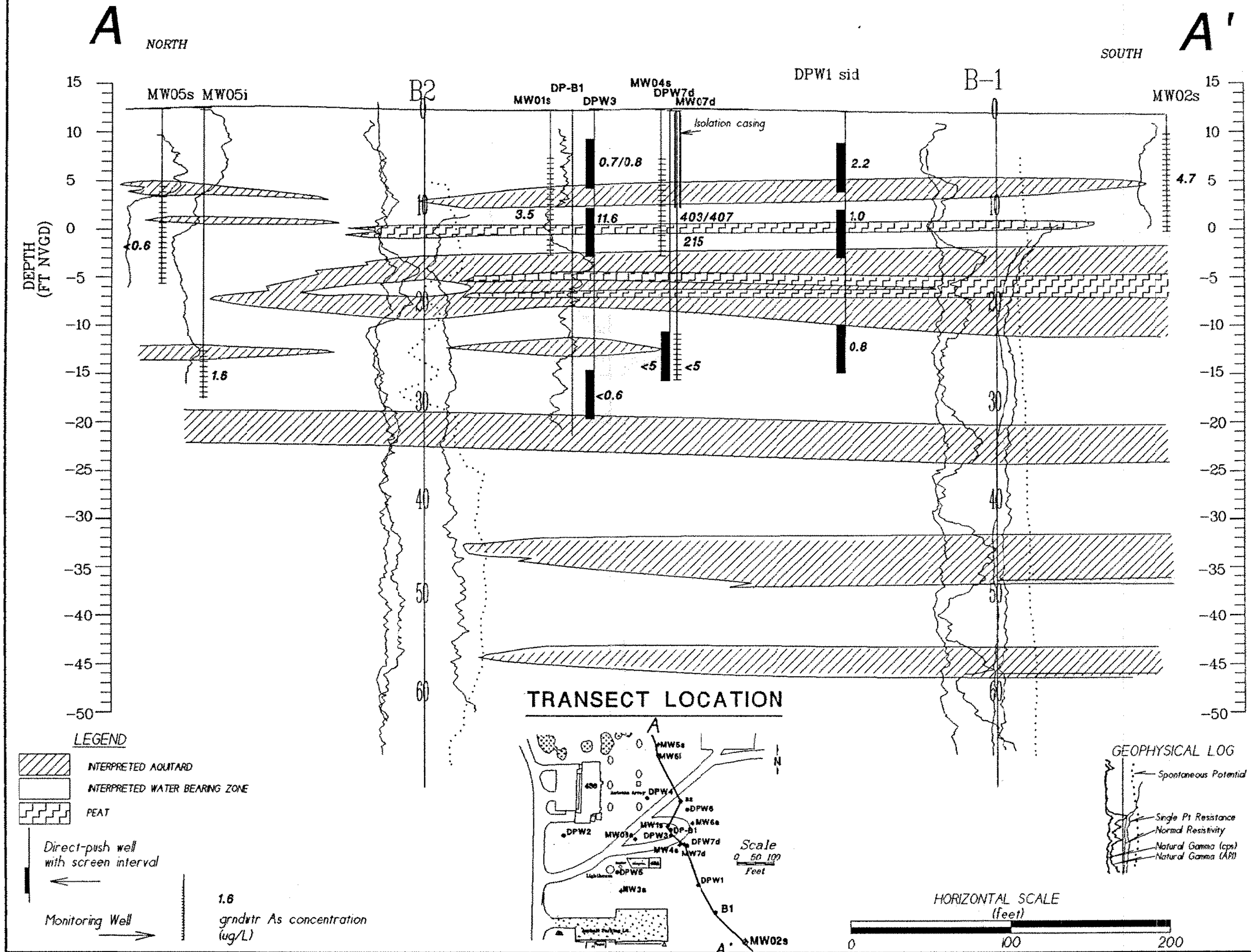

FIGURE 3-5

NORTH-SOUTH CROSS SECTION DIAGRAM WITH GROUNDWATER ARSENIC CONCENTRATIONS (ug/L)
SWMU-15
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY
NAVSTA MAYPORT, FLORIDA

ICON
6160 Perkins Road Suite 100 Baton Rouge, LA 70808

File Name:	Date: 12/23/98
Project Number: 9052-001-0300	Source: Field Measurement ICON Env. Svcs.; 1993; 1998
Revision Number	
File Directory	
Drawn By	

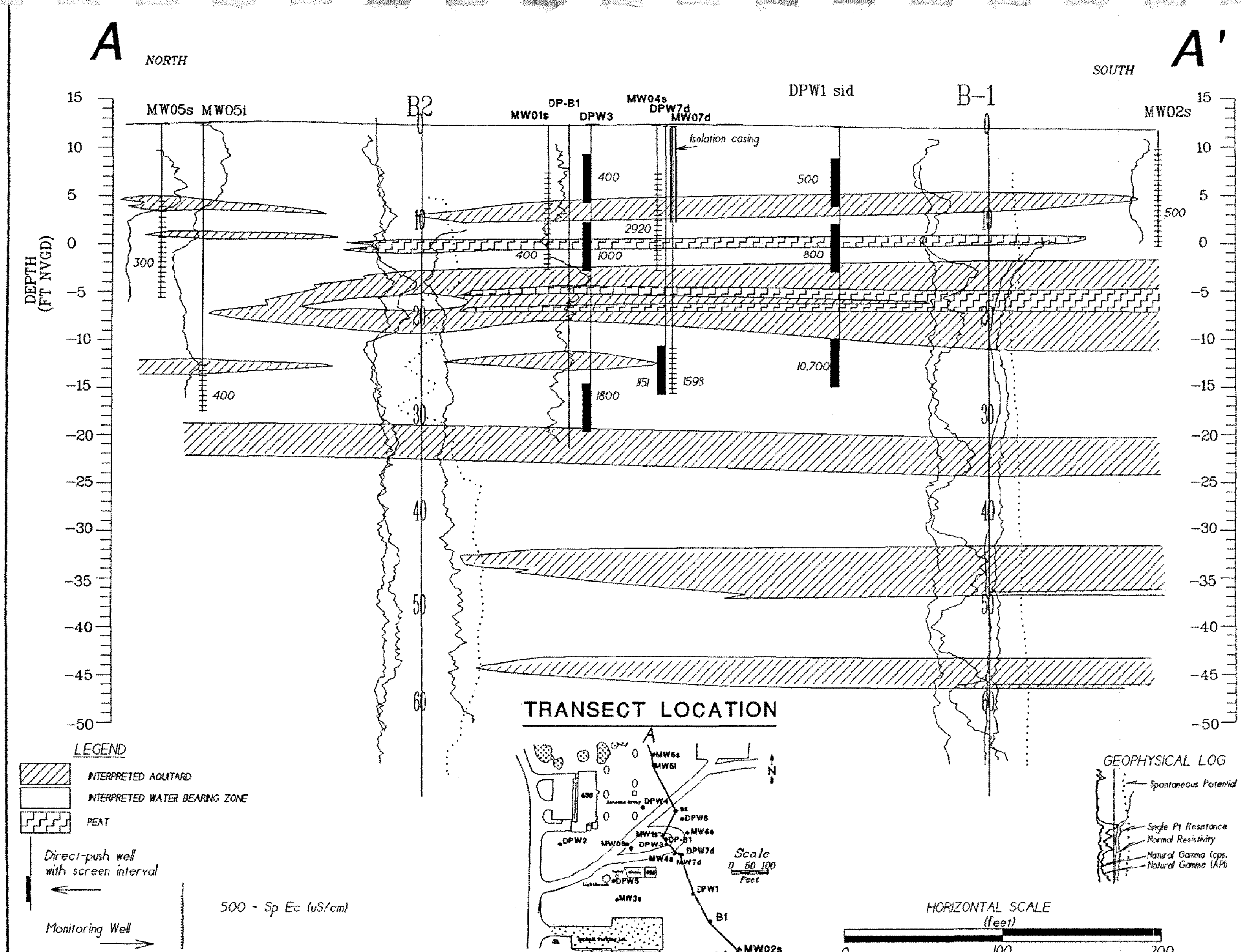

FIGURE 3-8

NORTH-SOUTH CROSS SECTION DIAGRAM WITH GROUNDWATER SPECIFIC CONDUCTANCE READINGS (SEP 1997)

SWMU-15

ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY

NAVSTA MAYPORT, FLORIDA

ICON
6160 Perkins Road Suite 100 Baton Rouge, LA 70808

File Name:
Project Number: 9052-001-0300
Revision Number
File Directory
Drawn By

Date: 12/23/98
Source:
Field Measurement
ICON Env. Svcs.; 1993; 1998

SECTION 4

GROUNDWATER POTENTIOMETRIC DATA EVALUATION

4.0 GROUNDWATER POTENTIOMETRIC DATA EVALUATION

The top of casing and ground elevation of each conventional well and DPW, and the location of each well was determined by Holland & Bassett Professional Land Surveyors, Jacksonville, Florida. Depth to water measurements were recorded using a Slope Indicator electronic water level indicator. Depth to water measurements were conducted in conjunction with groundwater sampling both in May and September 1997. An additional round of depth to water readings were obtained within a period of no more than two hours on May 9, 1997 and September 3, 1997, to minimize the potential effects of tidal fluctuation. Top of casing elevation, depth to water readings, and potentiometric elevation for each site are presented in Tables 4-1 and 4-2.

4.1 BUILDING 191

Additional wells and DPWs were installed at Building 191 during the September 1997 sampling event. The potentiometric elevation on September 3, 1997 in each well was used to generate the potentiometric contour map presented as Figure 4-1. Because of a significant vertical hydraulic gradient, potentiometric maps were drawn on a layered basis for the following screened intervals:

Top of Zone A

Groundwater flow generally to the west shifting to the southwest along the southern site boundary, with apparent hydraulic loading (mounding) in the northeast, possibly related to leaky water lines; average horizontal hydraulic gradient of 0.029 in the northeast, and 0.0006 elsewhere across the site.

Mid-Zone A

Groundwater flow generally to the west in the northern half, and to the south in the southern half of the site at an average horizontal hydraulic gradient of 0.001.

Base of Zone A

Similar flow pattern to that in Mid-Zone A, with a similar average horizontal hydraulic gradient of 0.001.

Zone C

Groundwater flow to the west with gradually increasing gradient to the east at an average horizontal hydraulic gradient of 0.004.

The vertical potentiometric hydraulic gradient is illustrated in cross section diagrams as Figures 4-2 (east-west) and 4-3 (north-south). The area of mounding at the top of Zone A in the northeast portion of the site (Figure 4-2), combined with an upward vertical hydraulic gradient near DPW1 and DPW3 clusters, results in a lower potentiometric elevation at the Base of Zone A and in Zone B as compared to zones above and below. The vertical gradient flattens and is negligible at the northwest corner of the site. A downward vertical hydraulic gradient of 0.032 was observed to the west and south near clusters DPW8 and DPW7. The vertical gradient exceeded the horizontal gradient in this area.

Results of twinned DPW-conventional wells screened at identical vertical intervals for the September 1997 sampling event are as follows:

Potentiometric Elevation	DPW2d	MW7d	Variance (feet)	DPW8s	MW8s	Var. (ft)	DPW8i	MW8i	Var (ft)
(feet NVGD)	4.38	4.41	0.03	4.18	4.20	0.02	4.20	4.20	0

Potentiometric elevations in DPWs and conventional wells were in good agreement.

4.2 SWMU 15

One additional DPW and three conventional wells were installed at SWMU 15 during the September 1997 sampling event. The potentiometric elevation on September 3, 1997 in each well was used to create the potentiometric contour map presented as Figure 4-4. Because of a significant vertical hydraulic gradient, potentiometric maps were drawn on a layered basis for the following screened intervals:

Shallow Wells (generally screened in the dredge spoil within 9.5 feet below land surface)

Groundwater flow generally to the northwest towards the St. Johns River, shifting to the southwest along the southern site boundary at an average horizontal hydraulic gradient of 0.005.

Intermediate Wells (generally screened in native sediments at 10 to 15 feet below land surface)

Groundwater flow generally to the northwest in the northern half, and to the west in the southwest corner of the site at an average horizontal hydraulic gradient of 0.006.

Deep Wells (generally screened between the ranges of 22-27 and 27.5–32.5 feet below land surface)

Groundwater flow pattern characterized by a north-south trending elongate mound, with flow to the east and west at an average horizontal hydraulic gradient of 0.0008.

The vertical potentiometric hydraulic gradient is illustrated in a north-south cross section diagram in Figure 4-5. A downward vertical potentiometric gradient was observed across the site. A vertical hydraulic gradient of 0.144 was observed at well cluster DPW1. The vertical gradient exceeded the horizontal gradient in this area.

One pair of twinned DPW/conventional wells was installed at this site. The conventional well was installed through 10 feet of surface isolation casing. Results of the twinned DPW-Conventional wells screened at identical vertical intervals for the September 1997 sampling event are as follows:

Potentiometric Elevation	DPW7d	MW7d	Variance (feet)
(feet NVGD)	3.95	3.75	0.2

The potentiometric elevation in the DPW and conventional well is in poor agreement. The pH of DPW7d was 7.0. Initially, the pH of MW7d was elevated (11.0) during well development, and stabilized slightly above 9.0. This suggests that the well screen of MW7d may have been impacted by grout invasion during installation. Interpolation of potentiometric contours from the deep wells near this cluster illustrated on the potentiometric map (Figure 4-4) suggests that the DPW reading is most representative.

TABLE 4-1
BUILDING 191 HYDRAULIC HEAD DATA
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY
NAVSTA MAYPORT, FLORIDA

Well	TOC Elev. (ft NGVD)	Water Bearing Zone	Screened Interval (ft bls)	Screened Interval (ft NGVD)	MAY 9, 1997 Depth to Wtr (ft)	MAY 9, 1997 Wtr Elev. (ft NGVD)	3-Sep-97 Depth to Wtr (ft)	3-Sep-97 Wtr Elev. (ft NGVD)
MPT-TC-DPW1s	9.64	Top-A	3.0 - 8.0	6.64 - 1.64	3.18	6.46	3.35	6.29
MPT-TC-DPW1d	9.65	Base A / B	36.5 - 41.5	-26.85 - -31.85	4.96	4.69	5.04	4.61
MPT-TC-DPW2s	9.75	Top-A	3.0 - 8.0	6.75 - 1.75	5.15	4.60	5.36	4.39
MPT-TC-DPW2i	9.92	Mid-A	17.0 - 22.0	-7.08 - -12.08	5.35	4.57	5.53	4.39
MPT-TC-DPW2d	9.95	Base A	27.0 - 32.0	-17.05 - -22.05	5.43	4.52	5.57	4.38
MPT-TC-MW7d	10.06	Base A	27.0 - 32.0	-16.94 - -21.94	ni		5.65	4.41
MPT-TC-DPW3s	9.09	Top-A	3.0 - 8.0	6.09 - 1.09	3.59	5.50	4.74	4.35
MPT-TC-DPW3i	9.03	Mid-A	22.0 - 27.0	-12.97 - -17.97	4.39	4.64	4.38	4.65
MPT-TC-DPW3d	9.10	Base-A / B	35.5 - 40.5	-26.40 - -31.40	4.57	4.53	4.52	4.58
MPT-TC-DPW3dd	9.10	C	41.5 - 46.5	-32.40 - -37.40	4.97	4.13	3.64	5.46
MPT-TC-DPW4s	8.78	Top-A	3.0 - 8.0	5.78 - 0.78	4.27	4.51	4.45	4.33
MPT-TC-DPW4i	8.75	Mid-A	17.0 - 22.0	-8.25 - -13.25	4.25	4.50	4.40	4.35
MPT-TC-DPW4d	8.65	Base A	27.5 - 32.5	-18.85 - -23.85	4.18	4.47	4.36	4.29
MPT-TC-DPW5i	8.65	Base A	27.0 - 32.0	-18.35 - -23.35	4.37	4.28	4.50	4.15
MPT-TC-DPW6s	9.72	Top A	3.2 - 8.2	6.52 - 1.52	3.55	6.17	3.65	6.07
MPT-TC-DPW6i	9.84	Mid-A	22.0 - 27.0	-12.16 - -17.16	5.13	4.71	5.25	4.59
MPT-TC-DPW7s	9.68	Mid-A	10.0 - 15.0	-0.32 - -5.32	ni		5.66	4.02
MPT-TC-DPW7i	9.82	Base A	26.0 - 31.0	-16.18 - -21.18	ni		5.82	4.00
MPT-TC-DPW7d	9.74	Zone C	43.5 - 48.5	-33.76 - -38.76	ni		5.78	3.96
MPT-TC-DPW8s	8.72	Mid A	10.0 - 15.0	-1.28 - -6.28	ni		4.54	4.18
MPT-TC-MW8s	8.60	Mid-A	10.0 - 15.0	-1.40 - -6.40	ni		4.40	4.20
MPT-TC-DPW8i	8.70	Base A	26.0 - 31.0	-17.30 - -22.30	ni		4.50	4.20
MPT-TC-MW8i	8.65	Base A	26.0 - 31.0	-17.35 - -22.35	ni		4.45	4.20
MPT-TC-DPW8d	8.70	Zone C	41.0 - 46.0	-32.30 - -37.30	ni		4.98	3.72
MPT-TC-DPW9s	8.26	Base A	26.5 - 31.5	-18.24 - -23.24	ni		4.08	4.18
MPT-TC-DPW9i	8.27	Zone B	33.0 - 38.0	-24.73 - -29.73	ni		4.08	4.19
MPT-TC-DPW9d	8.32	Zone C	41.0 - 46.0	-32.68 - -37.68	ni		4.38	3.94
MPT-20-MW3s	12.01	Top-A	6.0 - 16.0	6.01 - -3.99	3.63	8.38	nm	
MPT-TC-MW4s	8.68	Top-A	5.0 - 15.0	3.68 - -6.32	4.12	4.56	4.30	4.38
MPT-TC-MW6s	9.84	Top-A	4.5 - 9.5	5.34 - 0.34	3.98	5.86	nm	
MPT-TC-MW8i	8.65	Base A	26.0 - 31.0	-17.35 - -22.35	ni		4.45	4.20

ni - not installed
nm - not measured

TABLE 4-2
SWMU 15 HYDRAULIC HEAD DATA
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY
NAVSTA MAYPORT, FLORIDA

Well	TOC Elev. (ft NGVD)	Screened Interval (ft bls)	Screened Interval (ft NVGD)	5-May-97 Depth to Wtr (ft)	5-May-97 Wtr Elev. (ft NGVD)	3-Sep-97 Depth to Wtr (ft)	3-Sep-97 Wtr Elev. (ft NGVD)
MPT-15-DPW1s	12.13	3.2 - 8.2	8.93 - 3.93	4.30	7.83	5.18	6.95
MPT-15-DPW1i	12.11	10.0 - 15.0	2.11 - -2.89	4.29	7.82	5.25	6.86
MPT-15-DPW1d	12.16	22.0 - 27.0	-9.84 - -14.84	7.67	4.49	7.94	4.22
MPT-15-DPW2s	10.83	3.2 - 8.2	7.63 - 2.63	4.16	6.67	5.05	5.78
MPT-15-DPW2d	10.81	27.5 - 32.5	-16.69 - -21.69	6.85	3.96	6.90	3.91
MPT-15-DPW3s	12.37	3.2 - 8.2	9.17 - 4.17	5.33	7.04	6.28	6.09
MPT-15-DPW3i	12.33	10.0 - 15.0	2.33 - -2.67	5.29	7.04	6.25	6.08
MPT-15-DPW3d	12.32	27.0 - 32.0	-14.68 - -19.68	n/r		8.18	4.14
MPT-15-DPW4s	12.23	3.2 - 8.2	9.03 - 4.03	6.48	5.75	7.24	4.99
MPT-15-DPW4i	12.23	10.0 - 15.0	2.23 - -2.77	6.85	5.38	7.40	4.83
MPT-15-DPW4d	12.27	27.5 - 32.5	-15.23 - -20.23	7.79	4.48	8.04	4.23
MPT-15-DPW5s	11.86	3.0 - 8.0	8.86 - 3.86	4.66	7.20	5.68	6.18
MPT-15-DPW5i	11.89	10.0 - 15.0	1.89 - -3.11	4.87	7.02	5.84	6.05
MPT-15-DPW5d	11.85	27.5 - 32.5	-15.65 - -20.65	7.65	4.20	7.80	4.05
MPT-15-DPW6s	12.73	3.0 - 8.0	9.73 - 4.73	5.61	7.12	6.66	6.07
MPT-15-DPW6i	12.75	10.0 - 15.0	2.75 - -2.25	5.33	7.42	6.24	6.51
MPT-15-DPW6d	12.70	27.5 - 32.5	-14.80 - -19.80	8.18	4.52	8.43	4.27
MPT-15-DPW7d	12.27	23.0 - 28.0	-10.73 - -15.73	ni		8.32	3.95
MPT-15-MW7d	12.45	23.0 - 28.0	-10.55 - -15.55	ni		8.70	3.75
MPT-15-MW1s	12.14	5.0 - 15.0	7.14 - -2.86	3.63	8.51	6.20	5.94
MPT-15-MW2s	11.77	2.5 - 12.5	9.27 - -0.73	4.12	7.65	4.23	7.54
MPT-15-MW3s	11.28	6.0 - 16.0	5.28 - -4.72	3.98	7.30	5.24	6.04
MPT-15-MW4s	12.18	5.0 - 15.0	7.18 - -2.82			5.84	6.34
MPT-15-MW5s	12.37	8.0 - 18.0	4.37 - -5.63			7.68	4.69
MPT-15-MW5i	12.45	25.0 - 30.0	-12.55 - -17.55			8.20	4.25
MPT-15-MW6s	12.83	4.5 - 9.5	8.33 - 3.33	ni		6.67	6.16
MPT-15-MW8s	11.88	4.5 - 9.5	7.38 - 2.38	ni		5.94	5.94

ni - not installed
nm - not measured

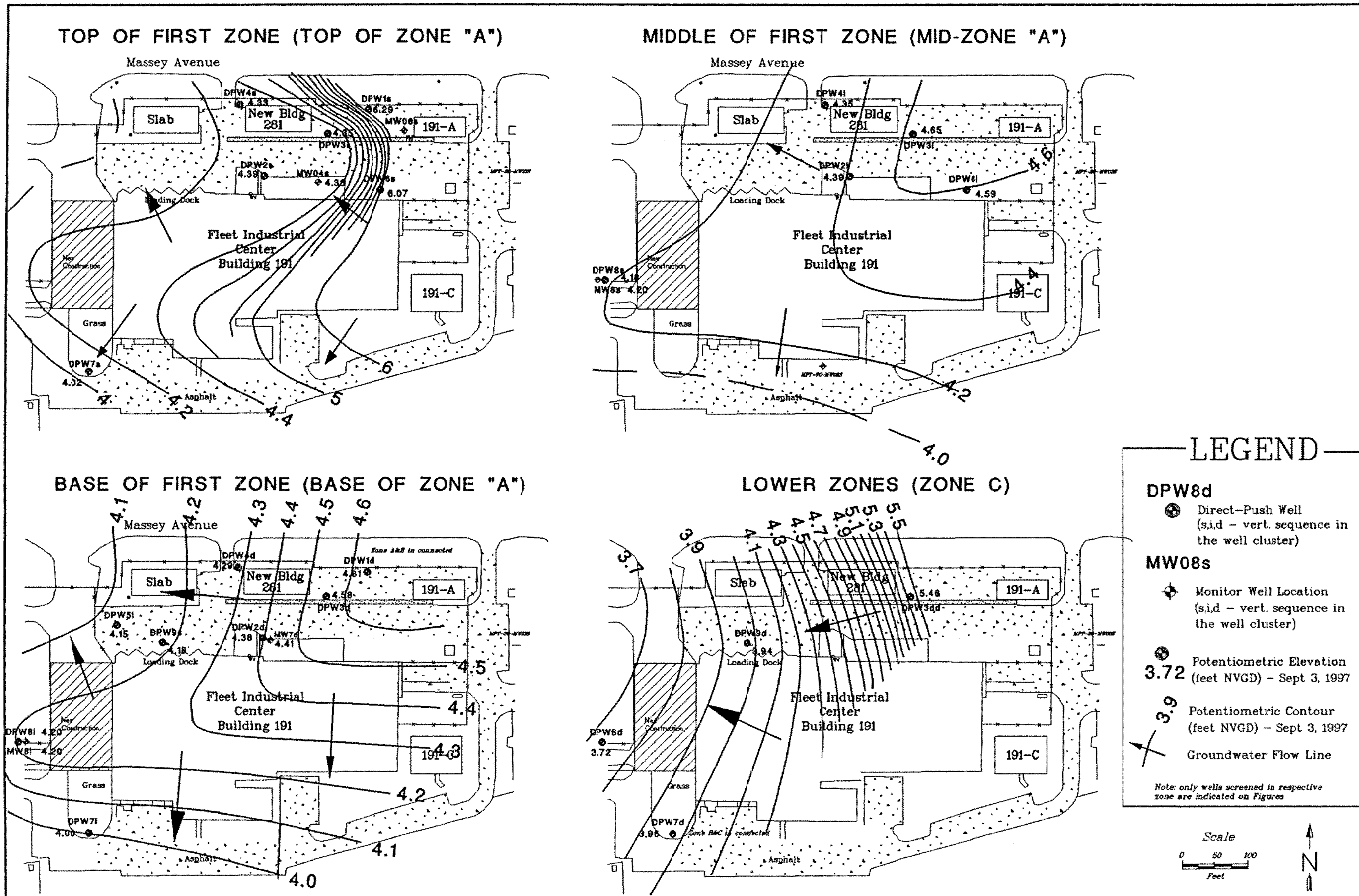

Figure 4-1

POTENTIOMETRIC CONTOURS, BUILDING 191 AREA, SEPTEMBER 3, 1997

NAVSTA MAYPORT, FLORIDA

ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY/METHODOLOGY

NAVAL FACILITIES ENGINEERING SERVICE CENTER (NFESC)

ICON Environmental Services

6160 Perkins Road Suite 100 Baton Rouge, LA 70808
(504) 769-2073 fax (504) 761-4489

File Name: 191-pots.gcd	Date: January 1997
Project Number: 9052-001-0100	Source: NFESC
Revision Number 0	Field Measurement
File Directory data\navy	ICON Env. Svcs.; 1996, 1997
Drawn By Greg Miller	

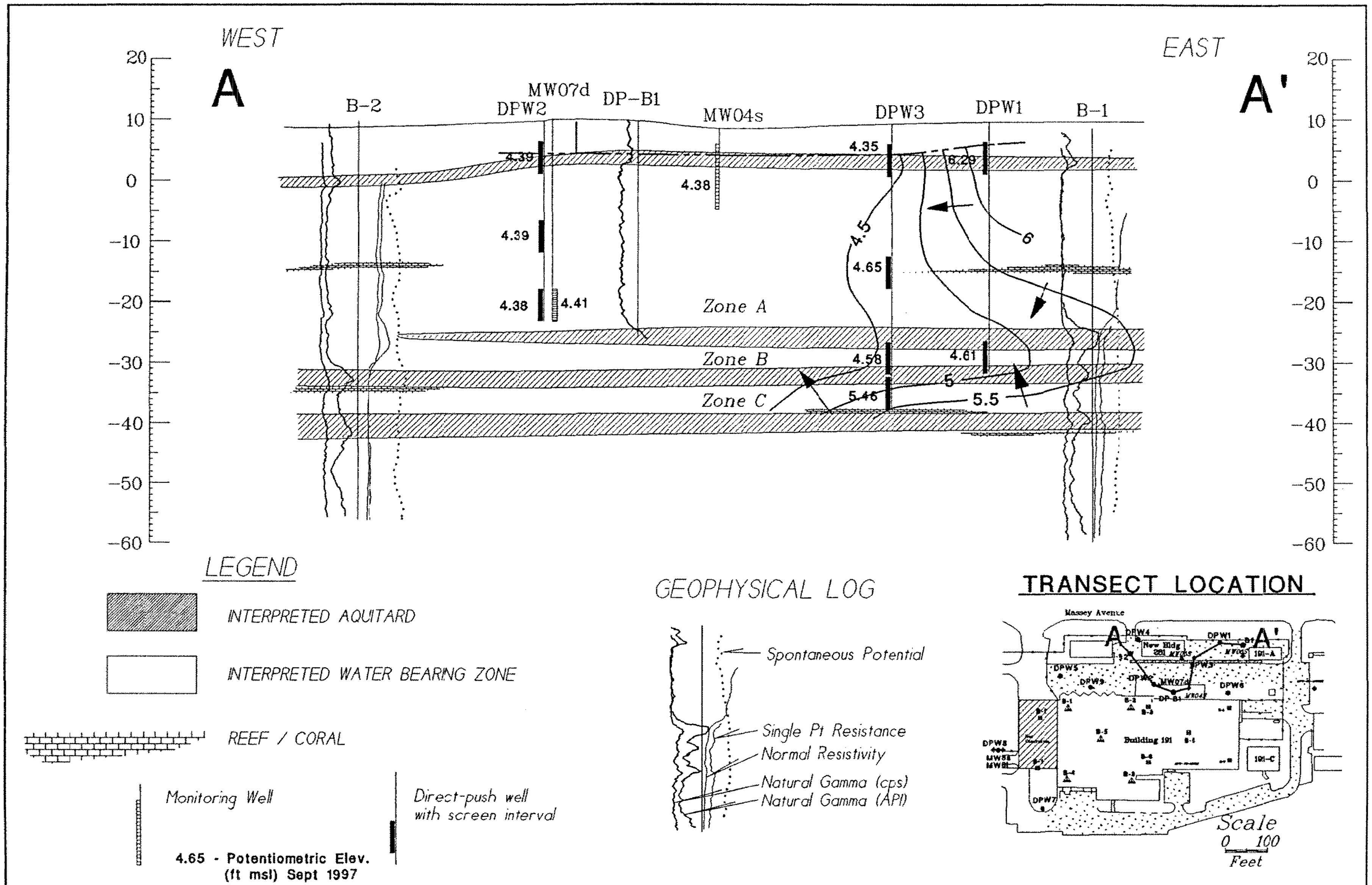

Figure 4-2

EAST-WEST CROSS SECTION DIAGRAM WITH POTENTIOMETRIC CONTOURS - SEPT 1997

BUILDING 191 AREA

ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY

NAVSTA MAYPORT, FLORIDA

ICON ENVIRONMENTAL SERVICES
5637 Superior Dr. Suite B-1 Baton Rouge, LA 70816

File Name:	Date: 05/23/97
Project Number: 9052-001-0300	Source: Field Measurement ICON Env. Svcs.; 1993; 1996
Revision Number / File Directory / Drawn By	

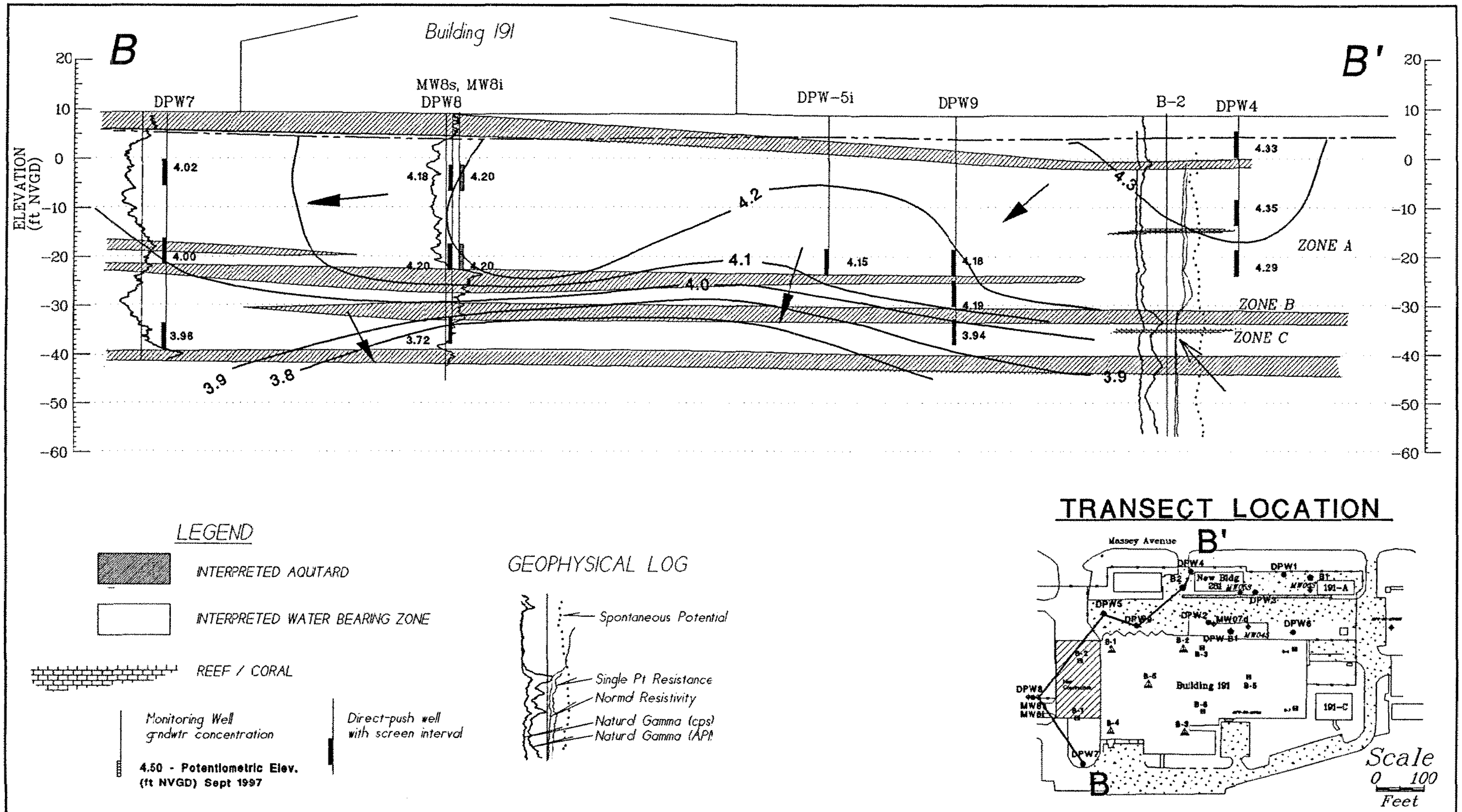

Figure 4-3

NORTH - SOUTH CROSS SECTION DIAGRAM WITH POTENTIOMETRIC CONTOURS - SEPT 1997

BUILDING 191 AREA

ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY

NAVSTA MAYPORT, FLORIDA

ICON ENVIRONMENTAL SERVICES
6160 Perkins Road Suite 100 Baton Rouge, LA 70808

File Name:	Date: 05/23/97
Project Number: 9052-001-0300	Source: Field Measurement ICON Env. Svcs.; 1993; 1996
Revision Number	
File Directory	
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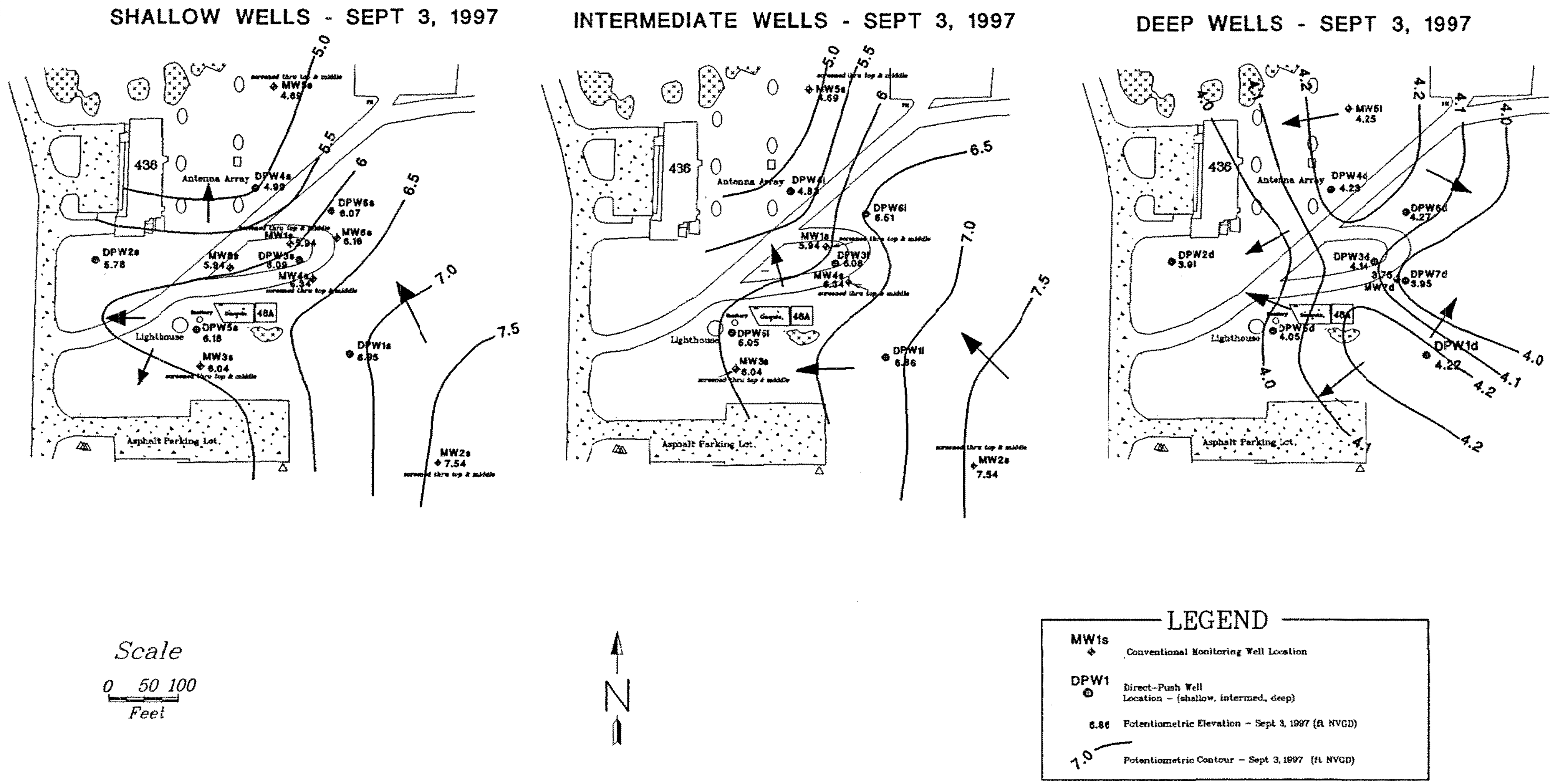


FIGURE 4-4
POTENTIOMETRIC CONTOURS, SEPTEMBER 3, 1997
SWMU 15 AREA
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY
U.S. NAVAL STATION, MAYPORT, FLORIDA

ICON ENVIRONMENTAL SERVICES
5637 Superior Dr. Suite B-1 Baton Rouge, LA 70816

File Name: Sitemap.gcd	Date: 01/21/97
Project Number: 9033-001-0100	Source: NFESC
Revision Number 2	Field Measurement
File Directory data\navy\	ICON Env. Svcs.; 1993; 1996
Drawn By GWM	

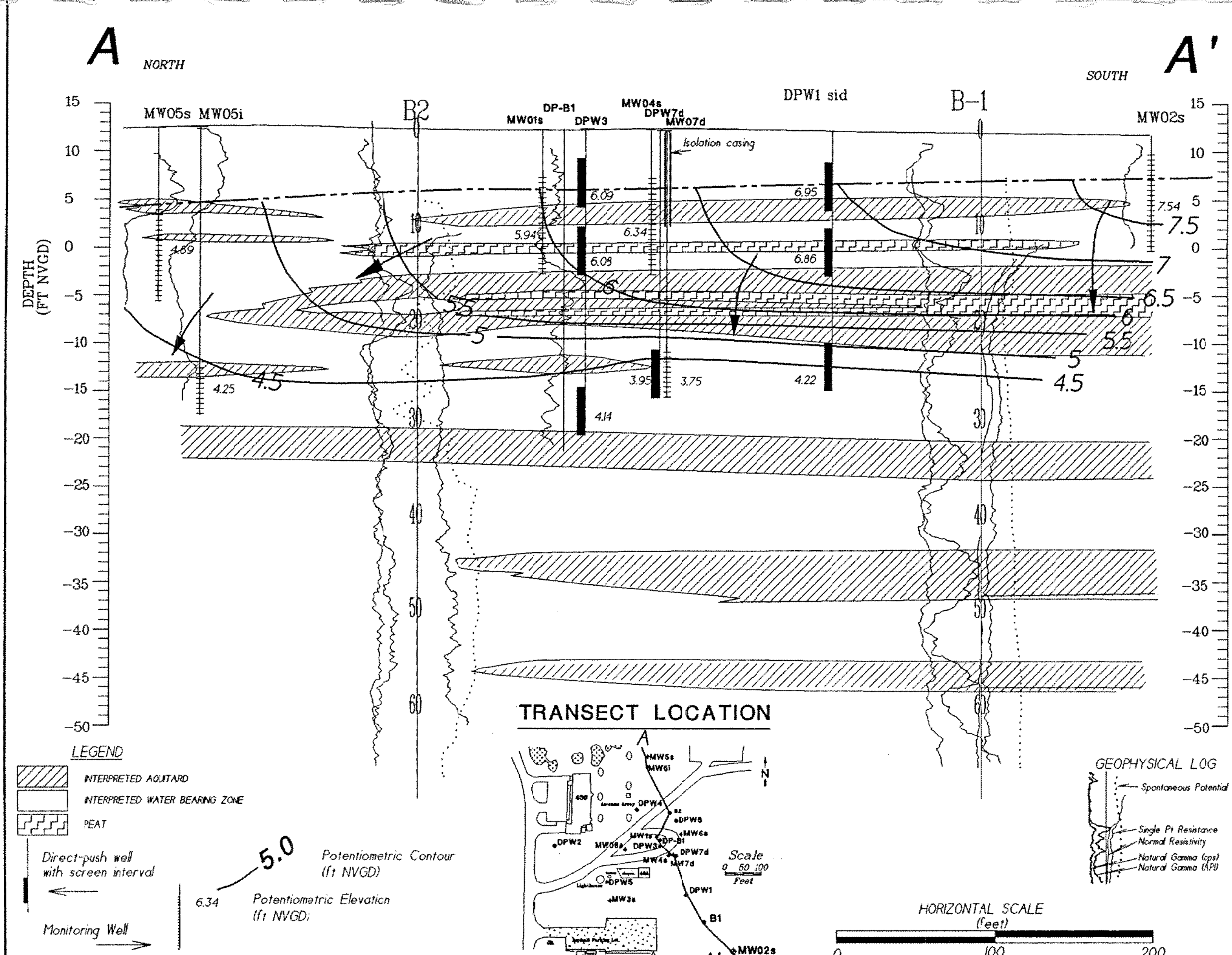


Figure 4-5

NORTH-SOUTH CROSS SECTION DIAGRAM WITH POTENTIOMETRIC CONTOURS - SEPT 3, 1997

SWMU-15

ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY

NAVSTA MAYPORT, FLORIDA

ICON
6160 Perkins Road Suite 100 Baton Rouge, LA 70808

File Name:	Date: 12/23/98
Project Number: 9052-001-0300	Source: Field Measurement ICON Env. Svcs.; 1993; 1996
Revision Number	
File Directory	
Drawn By	

SECTION 5

GEOLOGICAL EVALUATION

5.0 GEOLOGICAL EVALUATION

Subsurface lithology was characterized by sampling one 65 foot boring at each site and geophysically logging each borehole. The geophysical log deflections were compared to the core samples and site specific subsurface lithology was interpreted. An additional borehole was rotary washed and geophysically logged at each site directly across the area of interest from the sampled/geophysical logged borehole.

Additional through casing gamma ray geophysical logging occurred at Building 191. The gamma ray logs were run in the direct push drive assembly (through casing) to laterally correlate the soils between originally proposed and additional well points .

5.1 GEOLOGICAL EVALUATION OF SWMU 15

Descriptions of core samples obtained from the open-hole fluid-filled Borehole B1, and the geophysical log from the same borehole are presented as Figure 5-1. The borehole was continuously sampled to 20 feet (bls) and 80% of the soils were recovered and visually classified. After continuously sampling the borehole to 20 feet (bls) it was sampled at five foot centers to 60 feet (bls), yielding 21% of the soils in that interval recovered and visually classified. Upon completion of core sampling, the boring was geophysically logged, thereby providing data on the entire (100%) drilled interval.

The core sample descriptions based on the Unified Soil Classification System were compared to the geophysical logs in the field, and excellent agreement with lithology of core samples was observed. The lithological contacts were indicated on the geophysical logs by deflections in the gamma, resistivity and single point resistance curves. The gamma calibrated to an API standard indicated clay boundaries and generally exhibited a curve signature unique for a particular zone, and was useful for correlation. The gamma curve reading (counts per second) provided data to calibrate the gamma curved logged through pipe, and indicated a clay response at 20 counts per second. Log interpretations at Boring B-1 (correlated to cores from that boring) were then correlated to the geophysical log at boring B2 across the area of interest, and are presented as Figure 5-1A. Additionally, the existing monitor wells were geophysically logged utilizing one of the same gamma ray tools used during the open hole logging to obtain lithology and locations of bentonite seals.

Subsurface geology across the site from north to south was consistent from surface to approximately 36 feet (bls) consisting of 9 feet of Silty Sand (SM) underlain by Silty Clay (CL)/Silty Sand (SM) sequences with Organic Silty Clays (OL) and Peats within the interval of 15 feet to 21 feet (bls). Three groundwater bearing zones separated by aquitards were identified by the geophysical logs to the total depth of 36 feet (bls). Subsurface geology varied from north to south at the site below 35 feet (bls): the north portion was predominantly Poorly Sorted Sand (SP) with clayey layers; and the south portion had alternating sequences of Silty Sand (SM)/Clay (CH). A cross section diagram was prepared from correlations of the geophysical logs and is presented as Figure 5-2.

Sediments beneath SWMU-15 were probably deposited in a transitional environment in the littoral to tidal flat area. Below 36' (bls) sediments beneath the northern section of the site are represented by a tidal channel of the St. Johns river; and to the south were deposited in a brackish water marsh.

5.2 GEOLOGICAL EVALUATION OF BUILDING 191

Descriptions of the core samples obtained from the open-hole fluid-filled Borehole B1, and the geophysical log from the same borehole were interpreted and are presented as Figure 5-3. The borehole was continuously sampled to 20 feet (bls) and 63% of the soils were recovered and visually classified. After continuously sampling the borehole to 20 feet (bls), it was sampled at five foot centers to 65 feet (bls) yielding 21% of the soils in that interval recovered and visually classified. Upon completion of core sampling the boring was geophysically logged, thereby providing data on the entire (100%) drilled interval.

The core sample descriptions based on the Unified Soil Classification System were compared to the geophysical logs in the field, and excellent agreement with lithology of core samples was observed. Log interpretations at Boring B-1 (correlated to cores from that boring) were then correlated to the geophysical log at open-hole Boring B2 across the area of interest (Figure 5-3A), and to several through casing gamma ray logs in the area of interest. Cross sections with subsurface geology were generated based on the geophysical log data and are presented in Figures 5-4 and 5-5. Subsurface geology across the site from west to east was generally consistent from surface to approximately 65 feet (bls) and is as follows:

Depth **Feet (bls)**	**Description**
0.0' - 33.0'	Poorly Sorted Sand (SP), dark gray, shell layers and fragments, worm reef (3") at 24 feet (bls), herein denoted *Zone "A"*. This zone extends to 41.0 feet (bls) in the western section of the project area.
33.0' - 36.0'	Silty Clay (CL), gray, sand and shell lenses.
36.0' - 39.0'	Silty Sand (SM), gray with sand lenses, herein denoted *Zone "B"*. This zone exists only in the eastern section of the project area.
39.0' - 43.0'	Sandy Clay (SC), gray-green, with sand lenses .
43.0' - 47.0'	Silty Sand (SM), dark gray, clayey with shell fragments, shell reef (3") near base of zone, herein denoted *Zone "C"*.
47.0' - 49.0'	Silty Clay (CL), dark gray with shells and shell fragments,
49.0' - 64.0'	Poorly Sorted Sand (SP), dark gray, shell layers and fragments.

Sediments beneath Building 191 were probably deposited in a marine environment within the tidal delta offshore bar area.

The open-hole geophysical logging suite consisted of 2 gamma rays, single-point-resistance, 6-inch normal resistivity and spontaneous potential while the through casing geophysical log consisted of one gamma ray log. The gamma ray tool used in the direct push drive assembly utilized a Geiger Muller detector and was run on a time constant of 8 at a logging speed of 8 feet per minute to maintain consistency and detailed correlation of the gamma ray tools used in the open holes.

ICON ENVIRONMENTAL SERVICES

BOREHOLE GEOPHYSICAL LOG

ICON Environmental Services, Inc.
5637 Superior Drive, Baton Rouge, Louisiana 70816
(504) 291-9499

DATE: 4/24/97

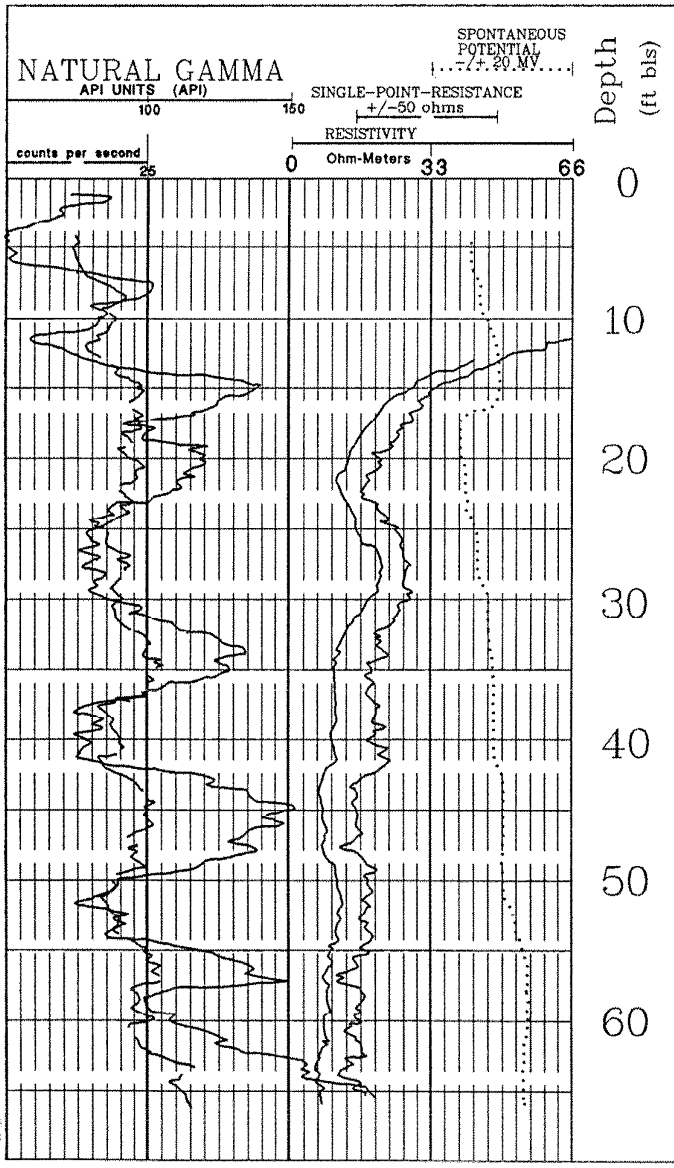
COMPANY:	U.S. Navy
HOLE NO:	MPT-15-B1
AREA:	SWMU-15
PARISH:	STATE: Florida
SECTION:	TOWNSHIP: RANGE: LOG MEASURED FROM: Grade

INITIAL RUN		RERUNS	
T.D. LOGGED:	66 FT.	T.D. LOGGED:	FT.
PROBE TYPE/SER. NO.:	Gamma (API), resistivity (6 inch)	PROBE TYPE/SER. NO.:	Gamma (cps), sp, resistance, /1
LOGGING SPEED:	12 FT/MIN.	LOGGING SPEED:	12 FT/MIN.
GAMMA-SCALE:	As indicated below CPS/IN	GAMMA-SCALE:	CPS/IN
TIME CONSTANT:	2 SEC.	TIME CONSTANT:	2 SEC.
RESISTIVITY (FULL SCALE)		RESISTANCE (FULL SCALE)	OHMS

WELL DATA

T.D. Logged	FT.	T.D. Drilled	68 FT.
Driller		Bit Size	4"
Type Fluid in Hole	Groundwater	Casing Size	
Fluid Level	Grade FT.	Bottom Hole Temp.	°F
Resistivity	OHM-M	LOG TIME	
Density		Start / Stop / Total	Minutes
Viscosity / Temp.	°F	Witnessed By:	Robert Stiles

OTHER SERVICES / REMARKS:



LOG OF BORING DIAGRAM

Lithology Interpretation	Depth (Ft)
SILTY SAND (SM) brown to gray, shell layers & fragments	0–8
SILTY CLAY (CL) gray, with silt & silty sand lenses	8–11
SHELLS (SH) & PEAT (Pt)	11–13
SILTY CLAY (CL) gray	13–16
PEAT (Pt) very dark gray clayey	16–18
ORGANIC SILTY CLAY (OL) very dark gray, silt lenses	18–23
SILTY SAND (SM) gray, shell layers clayey laminations	23–32
SILTY CLAY (CL) gray, silt lenses	32–37
SILTY SAND (SM) gray, with shell layers clay laminations	37–43
CLAY (CH) gray, shell and silty sand laminations increasing with depth	43–49
SILTY SAND (SM) gray, with shell layers, clayey	49–55
CLAY (CH) gray, with shell	55–58
SILTY SAND (SM) gray with clay laminations	58–63
CLAY (CH) gray	63–66

Depth (Ft)	Standard Penetration Test Blows\Foot	Percent Recovery	Sample Type & Location
2	16	100	Split Spoon
4	30	100	Split Spoon
6	17	50	Split Spoon
7	21	52	Split Spoon
9	3	50	Split Spoon
11	10	70	Split Spoon
13	<1	100	Split Spoon
15	<1	100	Split Spoon
17	<1	100	Split Spoon
19	<1	83	Split Spoon
25	3	79	Split Spoon
29	6	50	Split Spoon
35	<1	75	Split Spoon
41	7	25	Split Spoon
47	12	91	Split Spoon
52	15	50	Split Spoon
59	18	50	Split Spoon

LEGEND

- Shelby Tube
- Split Spoon

FIGURE 5-1
GEOPHYSICAL LOG AND CORE LOG OF BORING B-1
SWMU 15
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY
NAVSTA MAYPORT, FLORIDA

BOREHOLE GEOPHYSICAL LOG

ICON ENVIRONMENTAL SERVICES

ICON Environmental Services, Inc.
5637 Superior Drive, Baton Rouge, Louisiana 70816
(504) 291-9499

DATE: 4/25/97

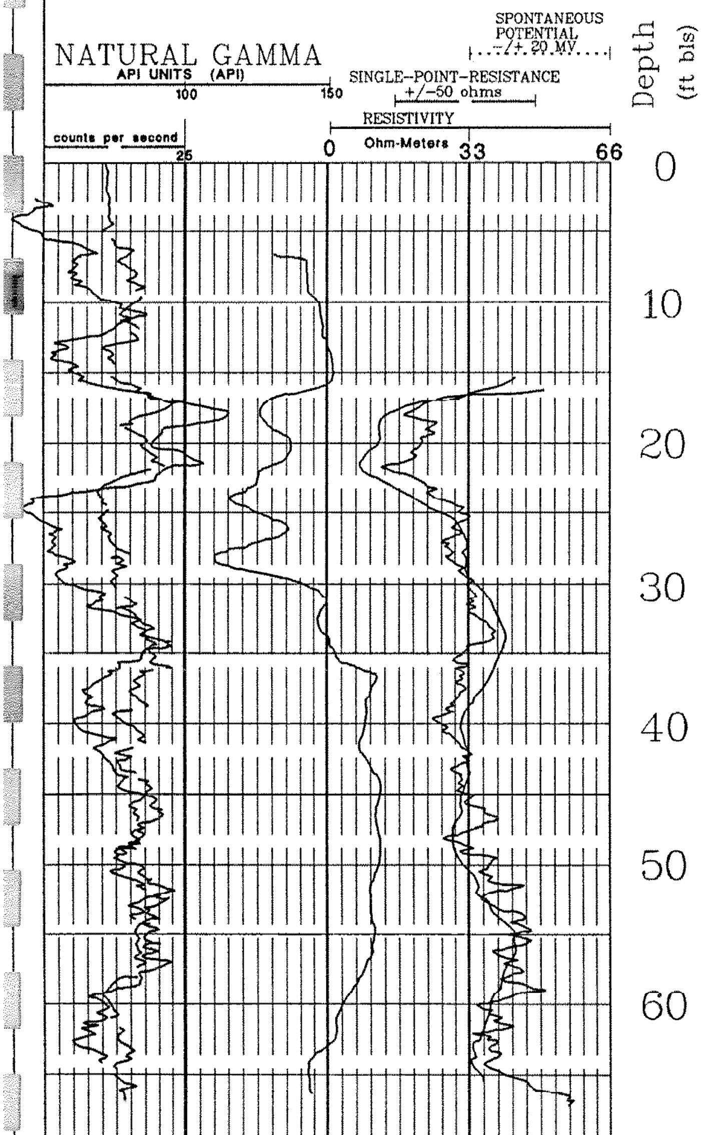
COMPANY: U.S. Navy	
HOLE NO.: MPT-15-B2	
AREA: SWMU-15	
CITY: Mayport	STATE: Florida
SECTION:	TOWNSHIP:
RANGE:	LOG MEASURED FROM: Grade

INITIAL RUN	RERUNS
T.D. LOGGED: 67 FT.	T.D. LOGGED: 67 FT.
PROBE TYPE/SER. NO.: Gamma (API), resistivity (6 inch)	PROBE TYPE/SER. NO.: Gamma (cps), sp, resistance, /1
LOGGING SPEED: 12 FT/MIN.	LOGGING SPEED: 12 FT/MIN.
GAMMA-SCALE: As indicated below CPS/IN	GAMMA-SCALE: CPS/IN
TIME CONSTANT: 2 SEC.	TIME CONSTANT: 2 SEC.
RESISTIVITY (FULL SCALE)	RESISTANCE (FULL SCALE) OHMS

WELL DATA

T.D. Logged FT.	T.D. Drilled 68 FT.
Driller Layne Environmental	Bit Size 4"
Type Fluid in Hole Groundwater	Casing Size
Fluid Level Grade FT.	Bottom Hole Temp. °F
Resistivity OHM-M	LOG TIME
Density	Start Stop Total Minutes
Viscosity Temp. °F	Witnessed By: Robert Stiles

OTHER SERVICES / REMARKS:



LOG OF BORING DIAGRAM

Lithology Interpretation	SOIL PROFILE	Depth (Ft)	Standard Penetration Test Blows\Foot	Percent Recovery	Sample Type & Location
SILTY SAND (SM) white to gray		2, 4, 6, 8, 10, 12			
PEAT (Pt) wood		14, 16			
SILTY CLAY (CL) silt lenses and sand lenses		18, 20, 22			
POORLY SORTED SAND (SP)		24, 26, 28, 30, 32			
SILTY CLAY (CL)		34			
CLAYEY silty clayer layer CLAYEY		36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68			

FIGURE 5-1A
GEOPHYSICAL LOG OF B-2 WITH INTERPRETATIONS
SWMU 15
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHOLOGY
NAVSTA MAYPORT, FLORIDA

LEGEND

- Shelby Tube
- Split Spoon

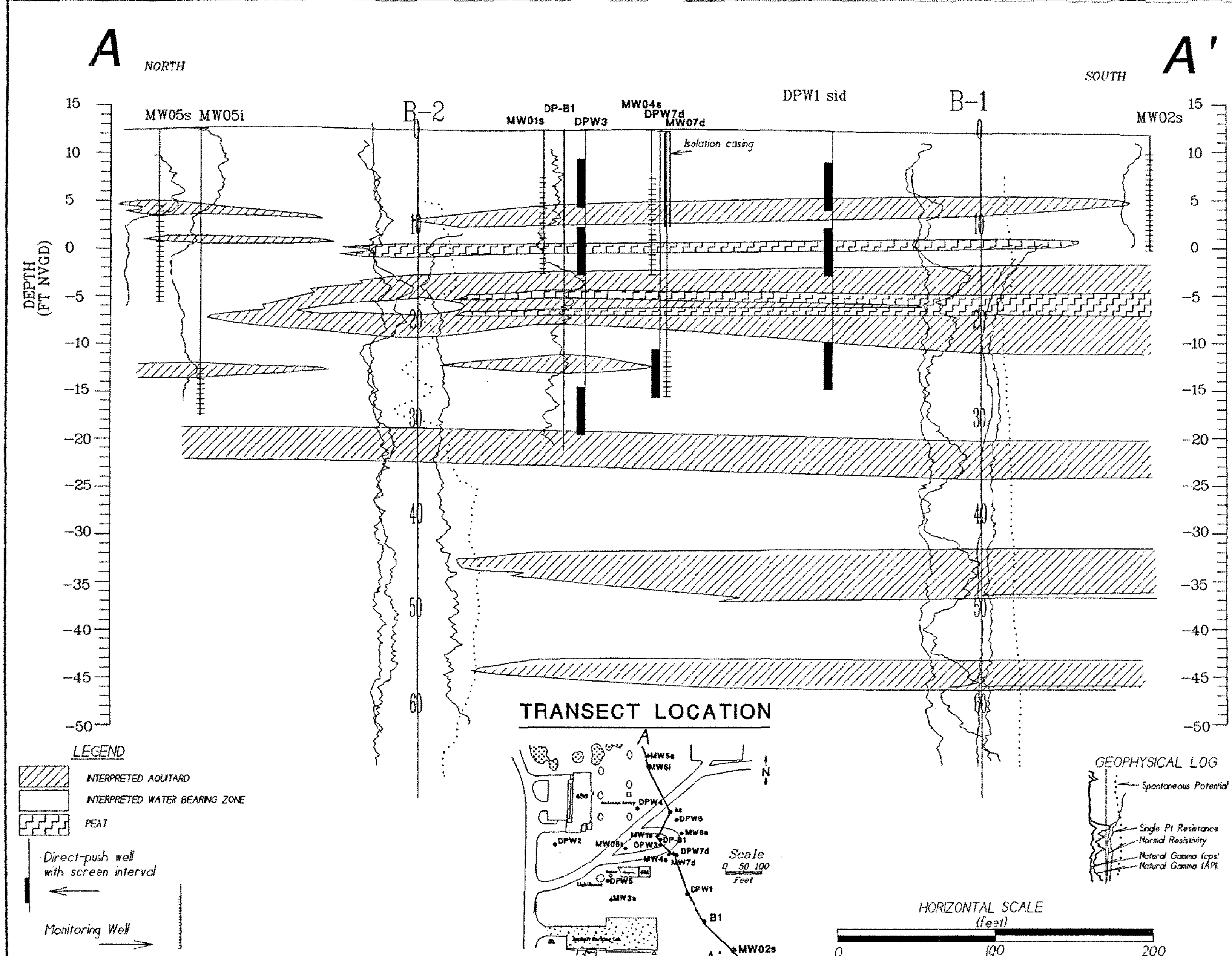


FIGURE 5-2

NORTH-SOUTH CROSS SECTION DIAGRAM WITH GEOLOGICAL INTERPRETATION

SWMU-15

ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY

NAVSTA MAYPORT, FLORIDA

ICON

6160 Perkins Road Suite 100 Baton Rouge, LA 70808

File Name:	Date: 12/23/98
Project Number: 9052-001-0300	Source: Field Measurement ICON Env. Svcs.; 1993; 1996
Revision Number	
File Directory	
Drawn By	

ICON ENVIRONMENTAL SERVICES

BOREHOLE GEOPHYSICAL LOG

ICON Environmental Services, Inc.
5637 Superior Drive, Baton Rouge, Louisiana 70816
(504) 291-9499

DATE: 5/1/97

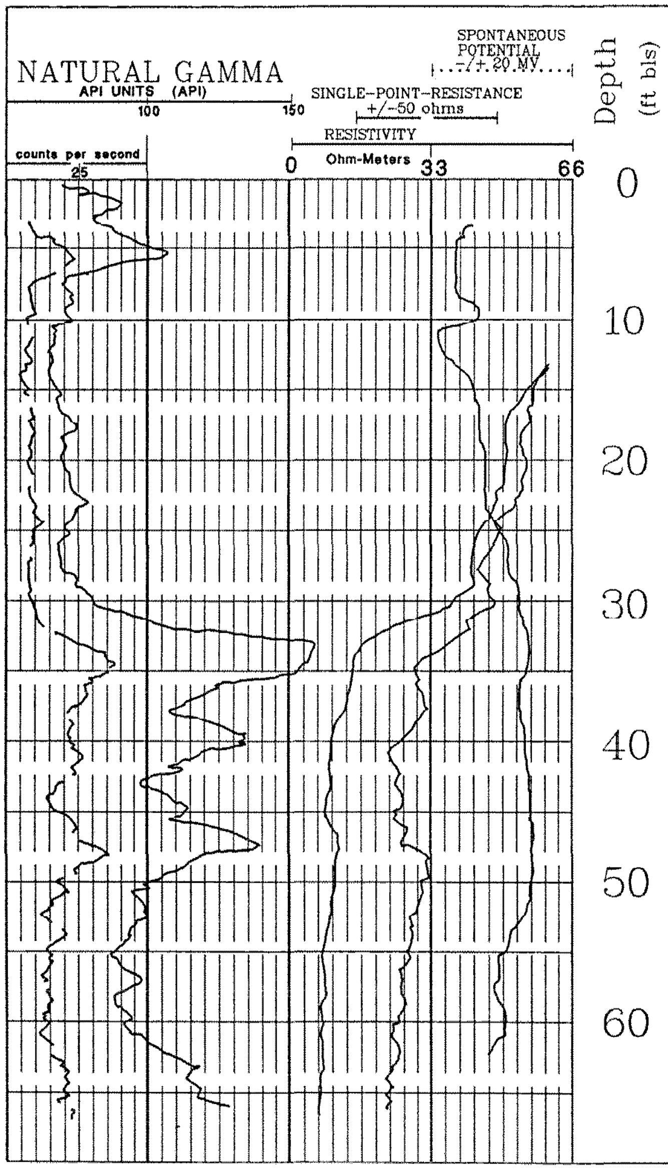
COMPANY:	U.S. Navy
HOLE NO.:	MPT-TC-B1
AREA:	Building 191
CITY:	Mayport
STATE:	Florida
SECTION:	
TOWNSHIP:	
RANGE:	
LOG MEASURED FROM:	

	INITIAL RUN	RERUNS
T.D. LOGGED:	67 FT.	67 FT.
PROBE TYPE/SER. NO.:	Gamma (API), resistivity (6 inch)	Gamma (cps), sp, resistance, /1
LOGGING SPEED:	12 FT/MIN.	12 FT/MIN.
GAMMA-SCALE:	As indicated below CPS/IN	CPS/IN
TIME CONSTANT:	2 SEC.	2 SEC.
RESISTIVITY (FULL SCALE) / RESISTANCE (FULL SCALE)		OHMS

WELL DATA

T.D. Logged	FT.	T.D. Drilled	68 FT.
Driller	Layne Environmental	Bit Size	4"
Type Fluid in Hole	Groundwater	Casing Size	
Fluid Level	Grade FT.	Bottom Hole Temp.	°F
Resistivity	OHM-M	LOG TIME	
Density		Start / Stop / Total	Minutes
Viscosity	Temp. °F	Witnessed By:	Robert Stiles

OTHER SERVICES / REMARKS:



LOG OF BORING DIAGRAM

Lithology Interpretation	Depth (Ft)	Standard Penetration Test Blows\Foot	Percent Recovery
POORLY SORTED SAND (SP) dark gray; peat layer; reef at 24'	0–2	21	90
	2–4	15	80
	4–6	5	20
	6–8	2	50
	8–10	9	90
	10–12	21	60
	12–14	21	50
	14–16	29	65
	16–18	36	65
	18–20	40	70
	24	~~31~~	~~100~~
	28–30	38	65
SILTY CLAY (CL) gray with sand and shell lenses, reef	34	~~>50~~	~~100~~
SILTY SAND (SM) gray, sand lenses			
SANDY CLAY (SC) gray-green	38–40	18	70
SILTY SAND (SM) dark gray clayey shell fragments	44	~~13~~	~~60~~
SILTY CLAY (CL) shells			
POORLY SORTED SAND (SP) dark gray shell layers and fragments	48–50	28	80
	54		~~N/R~~
	58–60	17	70
	64		~~20~~

LEGEND

- Shelby Tube
- Split Spoon

FIGURE 5-3

GEOPHYSICAL LOG AND CORE LOG OF BORING B-1
BUILDING 191 AREA
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY
NAVSTA MAYPORT, FLORIDA

ICON ENVIRONMENTAL SERVICES

BOREHOLE GEOPHYSICAL LOG

ICON Environmental Services, Inc.
5637 Superior Drive, Baton Rouge, Louisiana 70816
(504) 291-9499

DATE: 5/2/97

COMPANY: U S Navy
HOLE NO.: MPT-TC-B2
AREA: Building 191
CITY: Mayport STATE: Florida
SECTION: TOWNSHIP: RANGE: LOG MEASURED FROM:

INITIAL RUN	RERUNS
T.D. LOGGED: 67 FT.	T.D. LOGGED: 67 FT.
PROBE TYPE/SER. NO.: Gamma (API), resistivity (6 inch)	PROBE TYPE/SER. NO.: Gamma (cps), sp, resistance, /1
LOGGING SPEED: 12 FT./MIN.	LOGGING SPEED: 12 FT./MIN.
GAMMA-SCALE: As indicated below CPS/IN	GAMMA-SCALE: CPS/IN
TIME CONSTANT: 2 SEC.	TIME CONSTANT: 2 SEC.
RESISTIVITY (FULL SCALE)	RESISTANCE (FULL SCALE) OHMS

WELL DATA

T.D. Logged FT.	T.D. Drilled 68 FT.
Driller Layne Environmental	Bit Size 4"
Type Fluid in Hole Groundwater	Casing Size
Fluid Level Grade FT.	Bottom Hole Temp. °F
Resistivity OHM-M	LOG TIME
Density	Start Stop Minutes Total
Viscosity Temp. °F	Witnessed By: Robert Stiles

OTHER SERVICES / REMARKS:

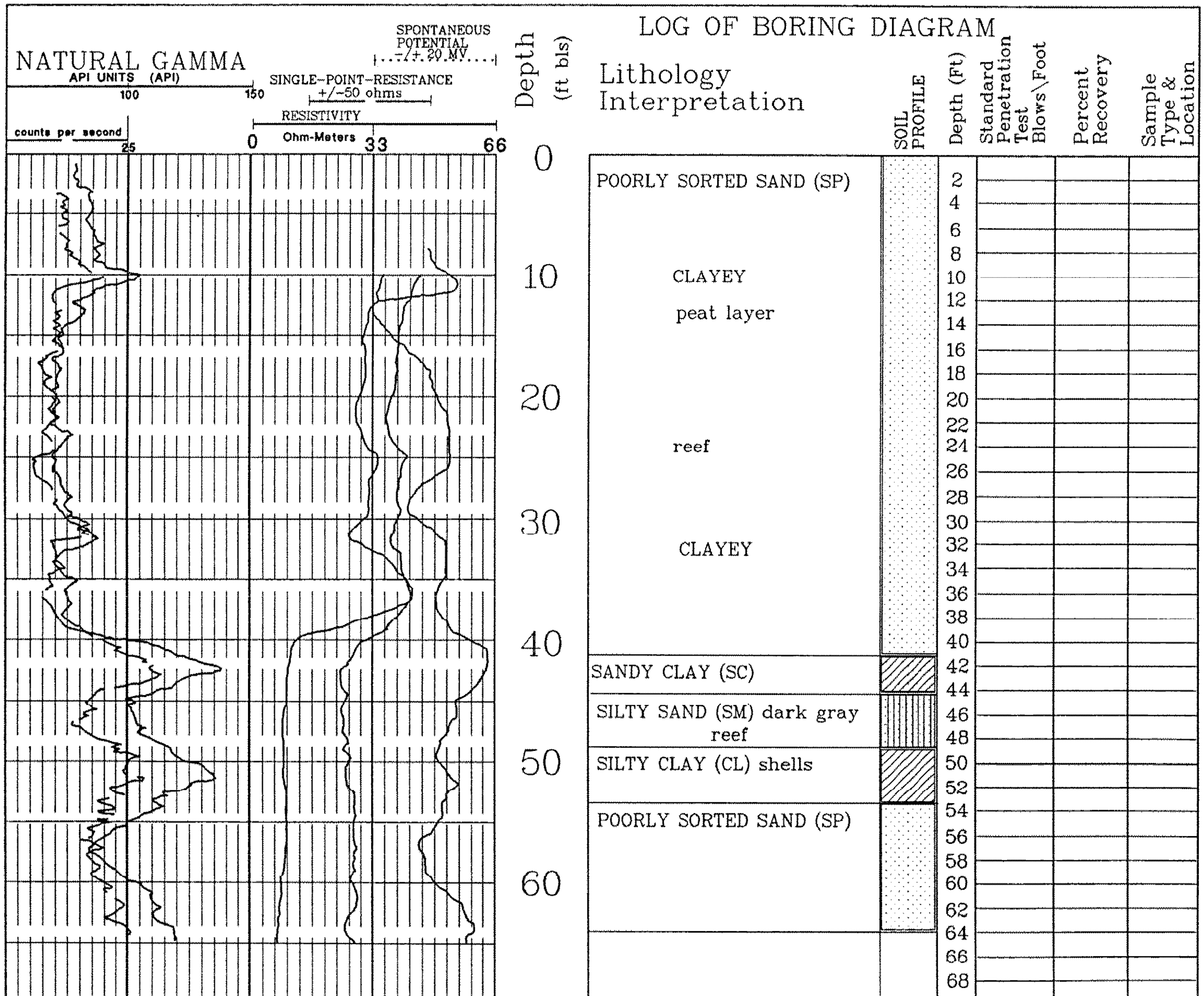


FIGURE 5-3A
GEOPHYSICAL LOG OF B-2 WITH INTERPRETATIONS
BUILDING 191 AREA
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY
NAVSTA MAYPORT, FLORIDA

LEGEND

Shelby Tube

Split Spoon

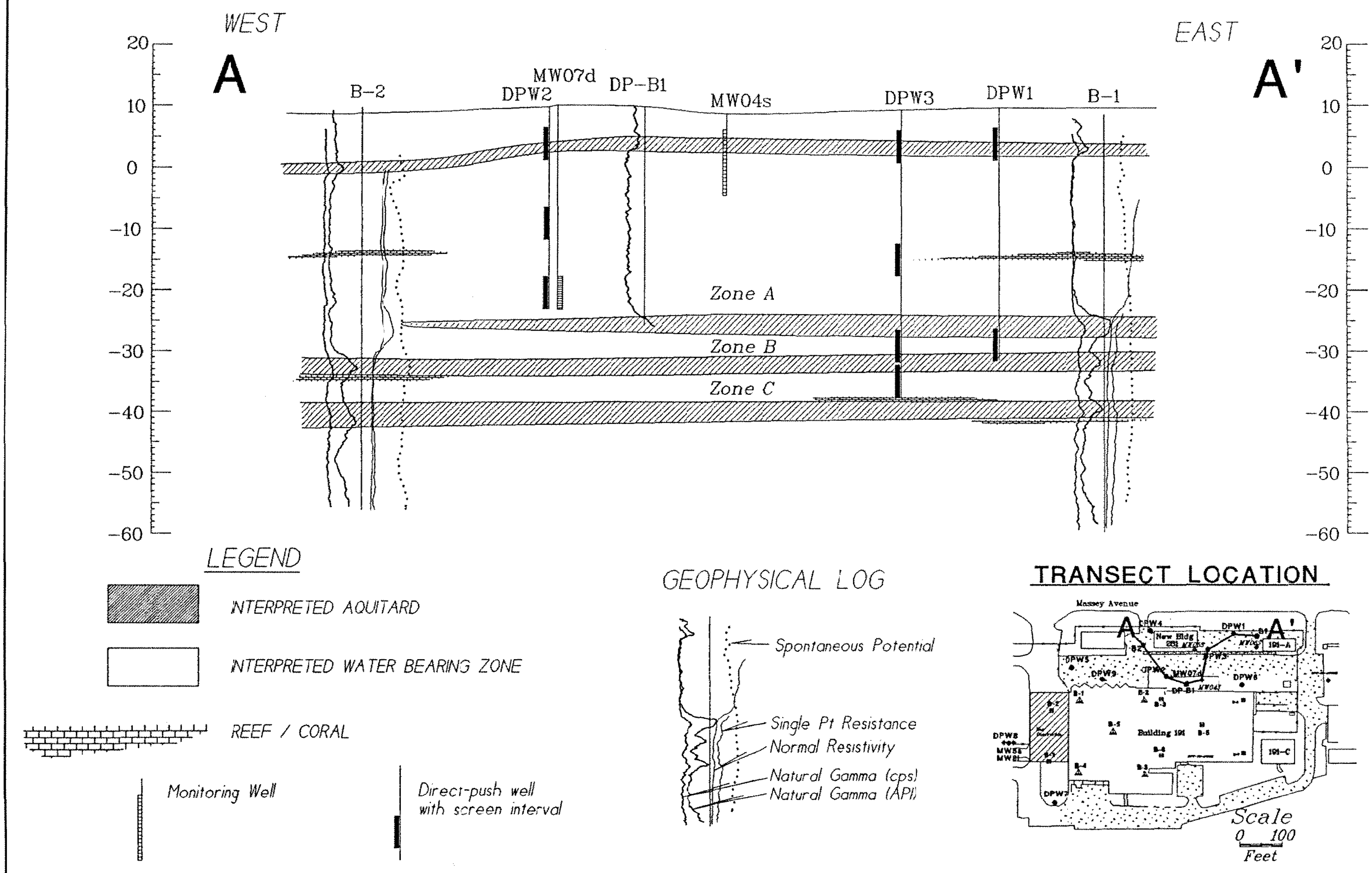


Figure 5-4

EAST-WEST CROSS SECTION DIAGRAM WITH GEOLOGICAL INTERPRETATION
BUILDING 191 AREA
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY
NAVSTA MAYPORT, FLORIDA

ICON ENVIRONMENTAL SERVICES
5637 Superior Dr. Suite B-1 Baton Rouge, LA 70816

File Name:
Project Number: 9052-001-0300
Revision Number
File Directory
Drawn By

Date: 05/23/97

Source:
Field Measurement
ICON Env. Svcs.; 1993; 1996

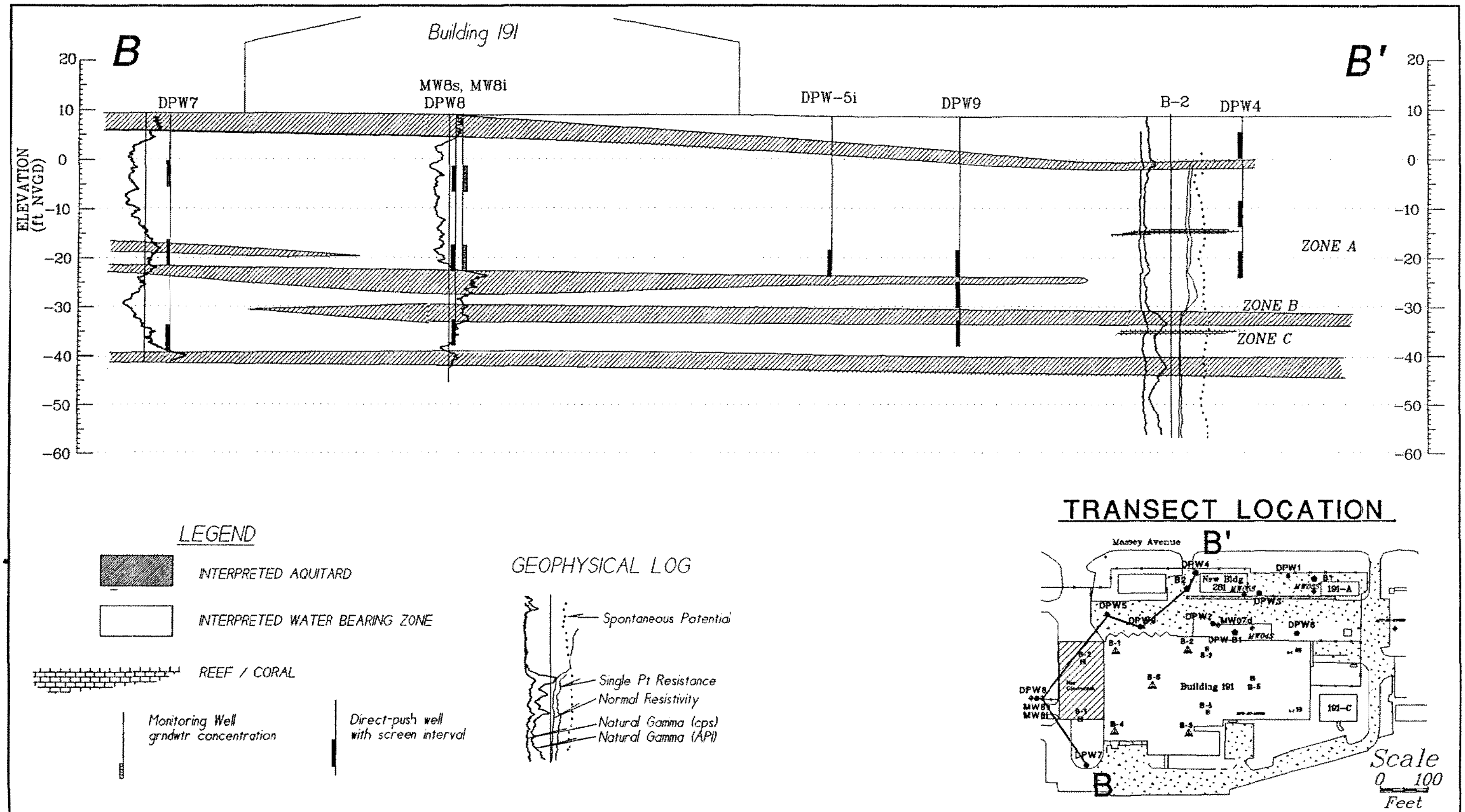


Figure 5-5

NORTH - SOUTH CROSS SECTION DIAGRAM WITH GEOLOGICAL INTERPRETATION

BUILDING 191 AREA

ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY

NAVSTA MAYPORT, FLORIDA

ICON ENVIRONMENTAL SERVICES
5637 Superior Dr. Suite B-1 Baton Rouge, LA 70816

File Name:	Date: 05/23/97
Project Number: 9052-001-0300	Source: Field Measurement ICON Env. Svcs.; 1993; 1996
Revision Number	
File Directory	
Drawn By	

SECTION 6

CEMENT-BENTONITE GROUT EVALUATION

6.0 CEMENT-BENTONITE GROUT EVALUATION

The DPW's were grouted using a 4% mix design of cement-bentonite. The mix consisted of 94 lbs. of type A Portland cement, 3.75 lbs. of bentonite (Pure Gold™) and 7.8 gallons of potable water. The mix had a slurry weight of 14.1 lbs. per gallon. The grout slurry was mixed in a 5 gallon bucket with a mixing paddle installed on a electrical drill. Before grouting with the cement-bentonite slurry an estimated 3 quarts of Volclay (bentonite slurry seal) was installed at the top of the packer seal.

The DPWs for SWMU-15 utilized from 1.5 to 3.5 times more more grout cement than the calculated annular volume for all DPWs. A summary of the actual volume of grout used vs. the calculated annular volume is presented on Table 6-1.

The DPWs for Building 191 utilized from 1.05 to 2.6 times more grout cement than the calculated annular volume for all DPWs. A summary of the actual volume of grout used vs. the calculated annular volume is presented on Table 6-2.

The additional grout volume used during the installations was probably due grout compaction and to infiltration into the sand and shell sediments.

TABLE 6-1
GROUT VOLUME USED VS. CALCULATED ANNULAR VOLUME
SWMU 15, NAVSTA MAYPORT, FLORIDA

d inner (in) 1 d outer (in) 2.25 r i 0.041667 r outer (ft) 0.09375

Well	TOC Elev. (ft NGVD)	Screened Interval (ft bls)	Calculated Annular Volume (gallons)	Actual Volume Used (gallons)	Excess Volume (gallons)
MPT-15-DPW1s	12.13	3.20 - 8.20	0.28	na	na
MPT-15-DPW1i	12.11	10.00 - 15.00	1.41	5.00	3.59
MPT-15-DPW1d	12.16	22.00 - 27.00	3.40	6.00	2.60
MPT-15-DPW2s	10.83	3.20 - 8.20	0.28	na	na
MPT-15-DPW2d	10.81	27.50 - 32.50	4.31	7.50	3.19
MPT-15-DPW3s	12.37	3.20 - 8.20	0.28	na	na
MPT-15-DPW3i	12.33	10.00 - 15.00	1.41	2.50	1.09
MPT-15-DPW3d	12.32	27.00 - 32.00	4.22	nm	nm
MPT-15-DPW4s	12.23	3.20 - 8.20	0.28	na	na
MPT-15-DPW4i	12.23	10.00 - 15.00	1.41	2.50	1.09
MPT-15-DPW4d	12.27	27.50 - 32.50	4.31	10.00	5.69
MPT-15-DPW5s	11.86	3.00 - 8.00	0.25	na	na
MPT-15-DPW5i	11.89	10.00 - 15.00	1.41	5.00	3.59
MPT-15-DPW5d	11.85	27.50 - 32.50	4.31	6.00	1.69
MPT-15-DPW6s	12.73	3.00 - 8.00	0.25	na	na
MPT-15-DPW6i	12.75	10.00 - 15.00	1.41	4.15	2.74
MPT-15-DPW6d	12.70	27.50 - 32.50	4.31	7.60	3.29
MPT-15-DPW7d	12.27	23.00 - 28.00	3.56	10.75	7.19

na - not applicable, shallow wells were not measured.
nm - measurement not logged.

TABLE 6-2
GROUT VOLUME USED VS. CALCULATED ANNULAR VOLUME
BUILDING 191, NAVSTA MAYPORT, FLORIDA

d inner (in) 1 d outer (in) 2.25 r i 0.04167 r outer (ft) 0.09375

Well	TOC Elev. (ft NGVD)	Screened Interval (ft bls)	Calculated Annular Volume (gallons)	Actual Volume Used (gallons)	Excess Volume (gallons)
MPT-TC-DPW1s	9.64	3.0 - 8.0	0.25	na	na
MPT-TC-DPW1d	9.65	36.5 - 41.5	5.80	nm	nm
MPT-TC-DPW2s	9.75	3.0 - 8.0	0.25	na	na
MPT-TC-DPW2i	9.92	17.0 - 22.0	2.57	nm	nm
MPT-TC-DPW2d	9.95	27.0 - 32.0	4.22	7.00	2.78
MPT-TC-DPW3s	9.09	3.0 - 8.0	0.25	na	na
MPT-TC-DPW3i	9.03	22.0 - 27.0	3.40	5.25	1.85
MPT-TC-DPW3d	9.10	35.5 - 40.5	5.63	8.00	2.37
MPT-TC-DPW3dd	9.10	41.5 - 46.5	6.63	8.60	1.97
MPT-TC-DPW4s	8.78	3.0 - 8.0	0.25	na	na
MPT-TC-DPW4i	8.75	17.0 - 22.0	2.57	nm	nm
MPT-TC-DPW4d	8.65	27.5 - 32.5	4.31	nm	nm
MPT-TC-DPW5i	8.65	27.0 - 32.0	4.22	nm	nm
MPT-TC-DPW6s	9.72	3.2 - 8.2	0.28	na	na
MPT-TC-DPW6i	9.84	22.0 - 27.0	3.40	6.50	3.10
MPT-TC-DPW7s	9.68	10.0 - 15.0	1.41	na	na
MPT-TC-DPW7i	9.82	26.0 - 31.0	4.06	10.00	5.94
MPT-TC-DPW7d	9.74	43.5 - 48.5	6.96	15.00	8.04
MPT-TC-DPW8s	8.72	10.0 - 15.0	1.41	na	na
MPT-TC-DPW8i	8.70	26.0 - 31.0	4.06	nm	nm
MPT-TC-DPW8d	8.70	41.0 - 46.0	6.54	nm	nm
MPT-TC-DPW9s	8.26	26.5 - 31.5	4.14	9.75	5.61
MPT-TC-DPW9i	8.27	33.0 - 38.0	5.22	13.75	8.53
MPT-TC-DPW9d	8.32	41.0 - 46.0	6.54	15.75	9.21

na - not applicable, shallow wells were not measured.
nm - measurement not logged.

SECTION 7

AQUIFER TEST EVALUATION

7.0 AQUIFER TEST EVALUATION

Aquifer testing was conducted using insitu tests, either the falling head method (adding known volume of water into the well), or the rising head method (bailing a known volume of water from the well). Because of the small well diameter of the DPWs, tests were predominantly conducted using the falling head tests. The falling head method consisted of pouring a known volume of well water back into a well when the water level stabilized. A Druck 50 psi 0.63-inch diameter pressure transducer and a Hermit Data Logger was used to measure the rate of water level decline. The pressure transducer was placed near the bottom of each well tested. Data was entered into a computer program, and time-drawdown curves were generated. Data was evaluated using the Bouwer and Rice Method (*WWR, June 1976; Groundwater V27, No. 3, June 1989*).

7.1 BUILDING 191

Twinned DPWs/conventional wells tested at Building 191 included:

DPW2d / MW7d
DPW8s / MW8s

Each of these twinned well clusters are screened well below the static water level, and were modelled as partially penetrating wells. Other wells tested included DPW2i, DPW2d, DPW7i, DPW7d, DPW9s, and DPW9i. Aquifer matrix consists of dense to very dense poorly sorted sand with shell fragments, deposited in a beach or marine tidal delta bar. Results of twinned DPW-conventional wells screened at identical vertical depths are as follows:

Test Results (ft/day)	DPW2d Falling Head	MW7d Rising Head	RPD between wells (%)
Test 1 - 8/28/97	50.53	114.49	*55.8%*
Test 2 - 8/28/97	50.53	95.76	*47.3%*
RPD (%) between tests	*0*	*16.4%*	
	DPW8s Falling Head	MW8s Falling Head	
Test 1 - 9/2/97	40.12	51.03	*21.8%*
RPD (%) between tests	*0.3%*	*26.5%*	

The calculated hydraulic conductivity of DPW8s was approximately twenty percent lower than the adjacent MW8s. The drawdown curves (Figure 7-1) indicates that the DPW data results in a more linear curve as compared to the conventional well. The early data of the DPW was viewed as most representative, because no artificial sandpack exists. Three straight-line inflections are evident in the conventional well. The late time data was used, to eliminate potential effects of an overdeveloped well bore *skin (Wellbore Skin Effect in Slug-Test Data Analysis for Low-Permeability Geologic Materials, Yang & Gates, Ground Water, Vol. 35,Number 6, Nov/Dec, 1997*). The proper "pick" was more easily obtained in the DPW data.

Figure 7-2 presents side-by-side plots of repeated falling head tests in DPW2d, and rising head (bail test) tests in MW7d. The plots indicated excellent repeatability and a single straight-line inflection on the curve of the DPW data. The plots of the adjacent conventional well indicate less defined straight line inflections; late time data of test 2 (more defined straight line inflection) was selected. Repeatability of the two tests in the conventional well was not as good as in the two tests conducted in the DPW. Once again, the calculated hydraulic conductivity of the DPW well was half the calculated result of the conventional well. Although the theory of the Bouwer and Rice Method states that falling head data should mirror rising head data in the same well, experience of this author suggests that differences may result from these two methods.

Calculated results of other wells tested at Building 191 are as follows:

Falling Head Test Results DPW Wells	Zone	Hydraulic Conductivity (ft/day)
DPW2s (test 1 and 2)	Top of Zone A	5.02 / 1.89
DPW2i (test 1 and 2)	Mid Zone A	27.76 / 27.21
DPW2d (test 1 and 2)	Base Zone A	46.31 / 46.15
DPW7i	Base Zone A	73.39
DPW7d	Zone C	13.98
DPW8s	Mid Zone A	30.65
DPW9s	Base Zone A	10.89
DPW9i	Zone B	1.43

Reports of previously conducted insitu radial hydraulic conductivity testing at Building 191 were made available to ICON. The range in hydraulic conductivity in shallow wells screened at zones analogous to the "Top of Zone A" were: (north of Building 191) 1.4 to 11.4 ft/day; and (south of Building 191) 11.5 – 20.5 ft/day. The two DPWs tested at Building 191 in similarly screened zones include DPW2s (screened 3-8 feet bls) and DPW8s (screened at 10 – 15 feet bls), with results of 5.02 ft/day and 30.65 ft/day correlate well to previously reported data.

7.2 SWMU 15

One twinned DPW/conventional well cluster was tested at SWMU 15: DPW7d / MW7d. Results of the drawdown plots are presented as Figure 7-3. Repeatability was excellent with the DPW, and fair for the conventional well.

Calculated hydraulic conductivity results are as follows:

Test Results (ft/day)	DPW7d Rising Head	MW7d Rising Head	RPD between wells (%)
Test 1 - 8/28/97	38.83	12.14	*42.9%*
Test 2 - 8/28/97	38.83	10.49	*72.9%*
RPD (%) between tests	*0*	*13.6%*	

Results of calculated hydraulic conductivity for DPW7d was 1/3 of that calculated for MW7d. It should be noted that MW7d yielded a 0.2 foot lower hydraulic head, and a pH of 9.0 as compared to 7.0 for the adjacent DPW7d. This suggests that some grout may have impacted the screened interval of MW7d.

Historical results of insitu radial hydraulic conductivity testing at SWMU 15 in wells screened at 5 – 15 feet bls yielded results of 3.1 – 5.9 ft/day (8 tests). The screened interval of DPW7d/MW7d was 23-28 ft bls. No historical results of wells screened at this interval are available for the SWMU 15 area. Reported results from the nearest wells screened in similar zones (RCRA Corrective Action Program, General Information Report, US Naval Station, Mayport, Florida, 1995, Table 3-2) are as follows:

SWMU 5, Screens from 20-25 feet bls; (5 tests) range of 36.2-50.5 ft/day
SWMU 16, Screens from 25-30 feet bls; (2 tests) range of 30.9-32.4 ft/day

These two SWMUs are located over 2000 feet to the south and north, respectively. The results of DPW2d are within this range, and are viewed as more representative than results from MW7d.

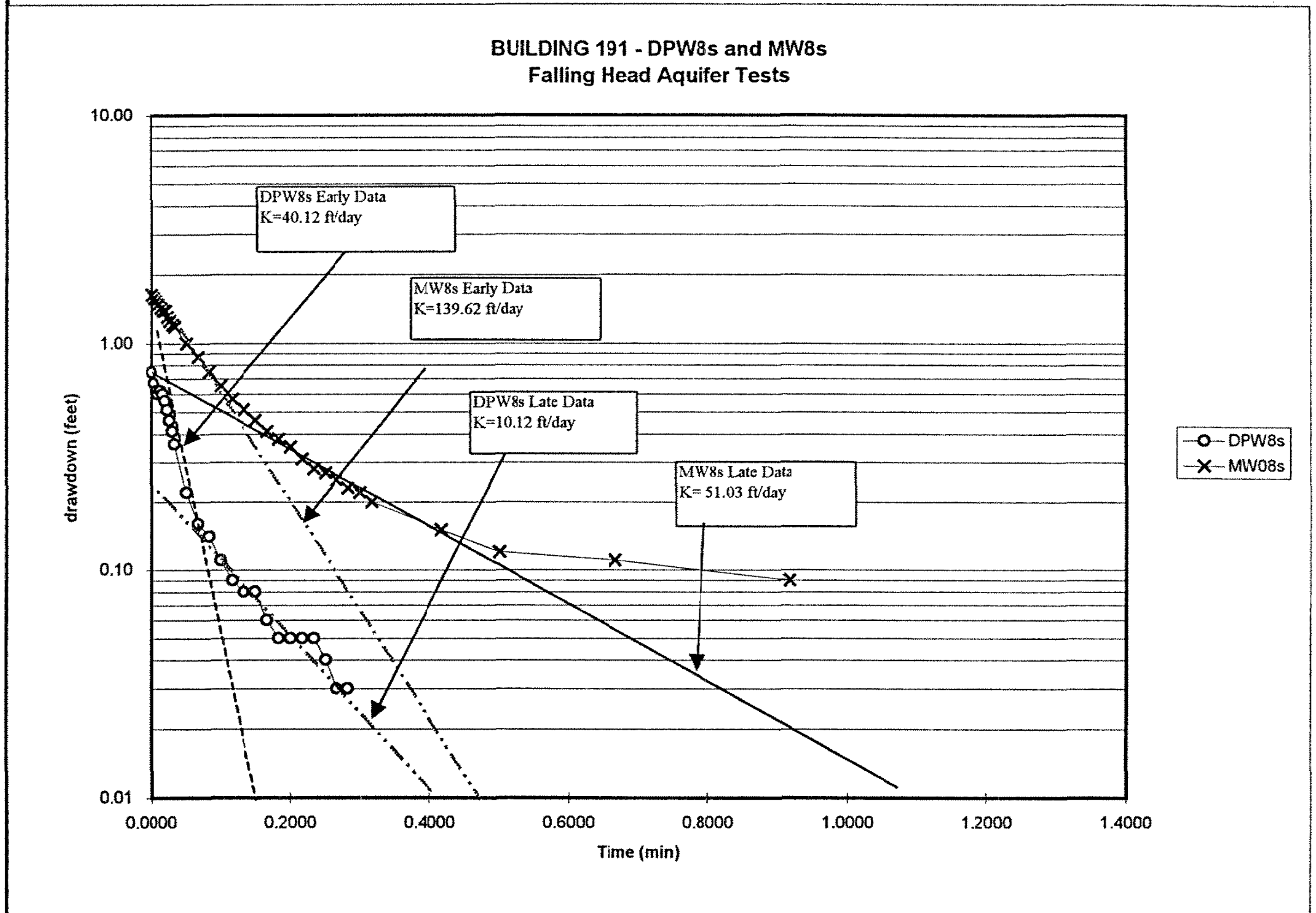
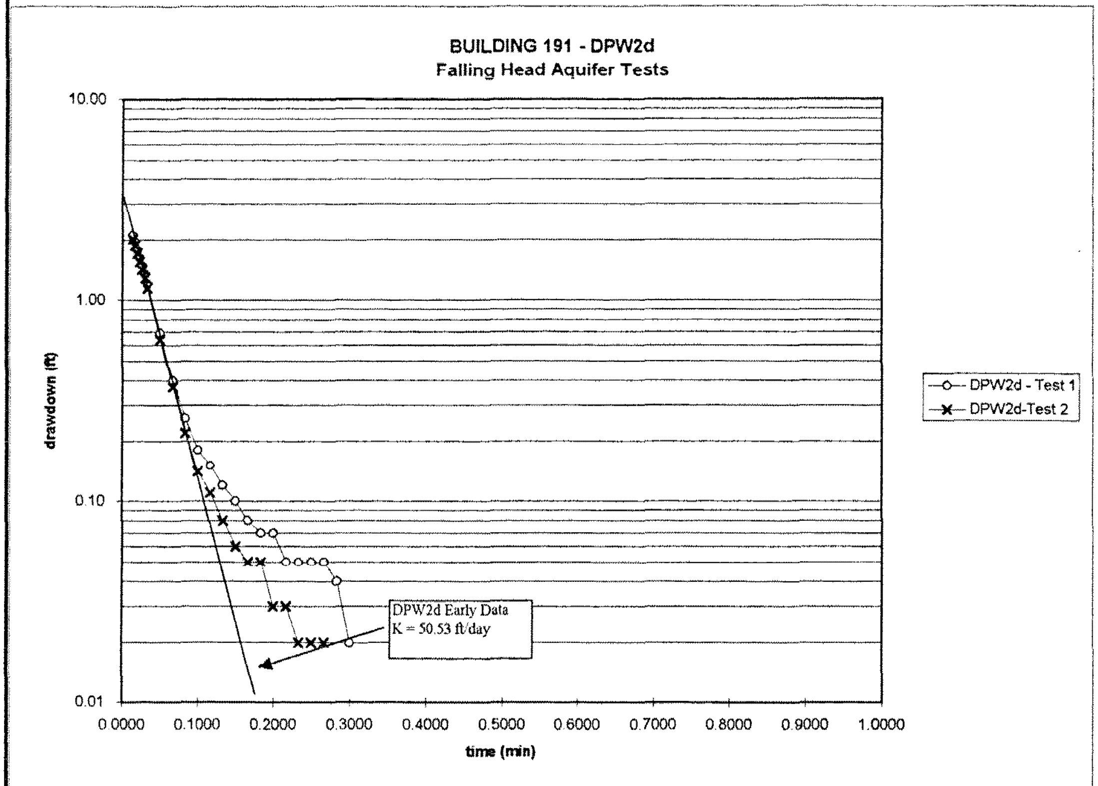


FIGURE 7-1
AQUIFER TEST COMPARISON - BUILDING 191 MW8s/DPW8s
BOUWER AND RICE DATA PLOTS
ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY
NAVSTA MAYPORT, FLORIDA

ICON
6160 Perkins Road Suite 100 Baton Rouge, LA 70808
(504) 769-2073 fax (504) 761-4489

File Name: FIG-ST	**Date:** Jan 98
Project Number:	**Source:** ICON, 1998
data\navy\d-report	



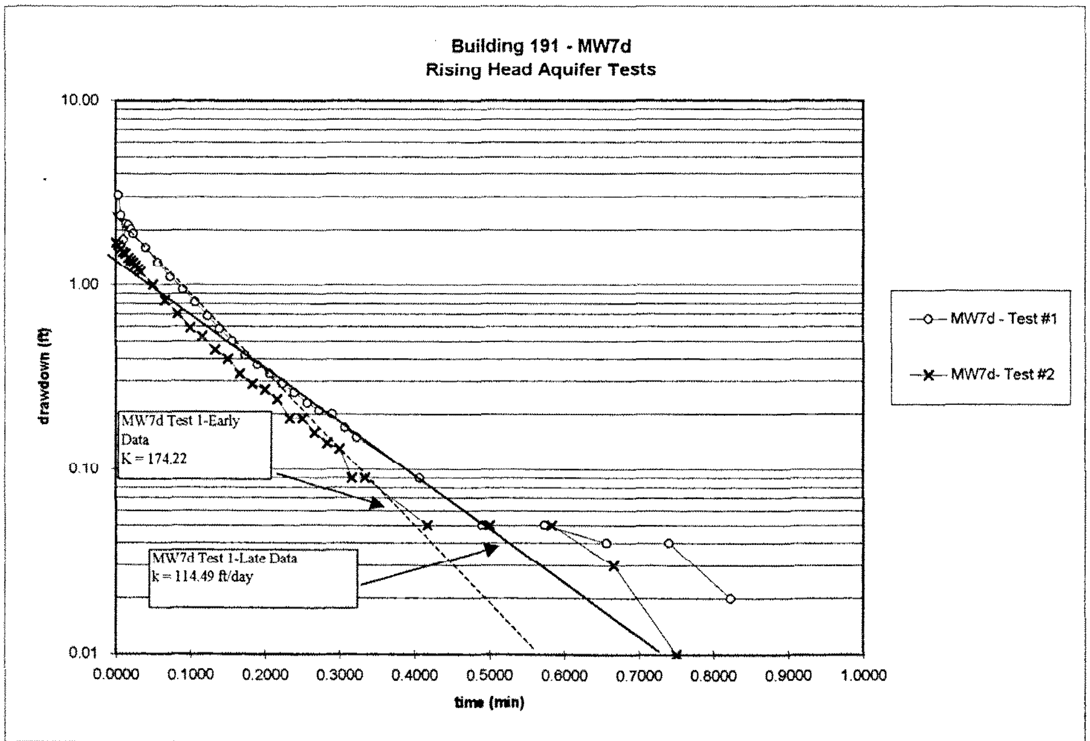
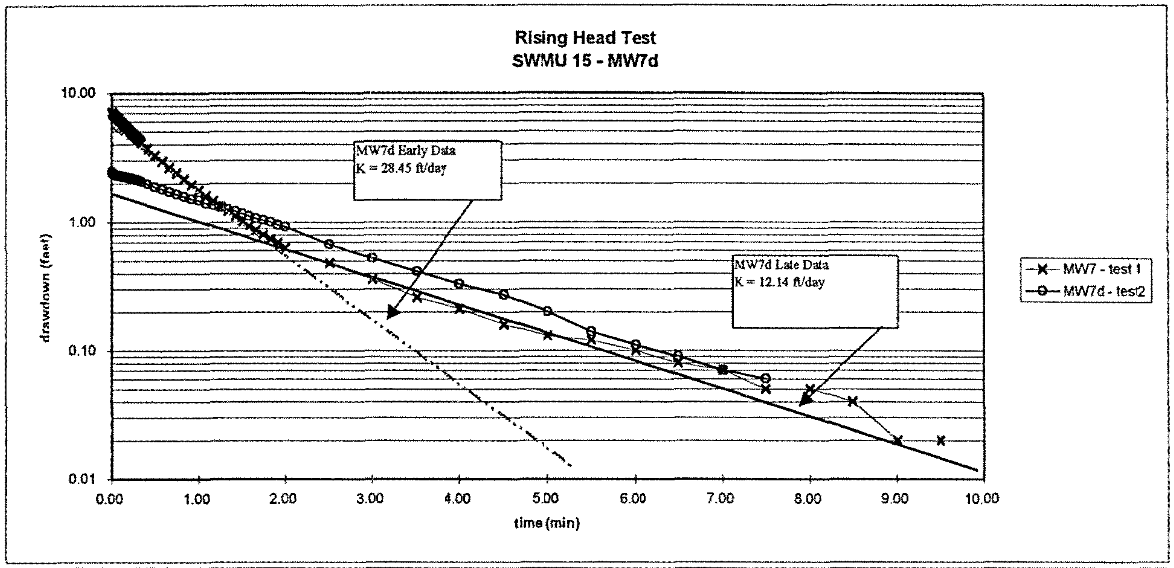


FIGURE 7-2 AQUIFER TEST COMPARISON - BUILDING 191 DPW2d/MW7d BOUWER AND RICE DATA PLOTS ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY NAVSTA MAYPORT, FLORIDA	ICON 6160 Perkins Road Suite 100 Baton Rouge, LA 70808 (504) 769-2073 fax (504) 761-4489 File Name: fig-st.xls Project Number: data\navy\d-report Date: January 1997 Source: ICON, 1997



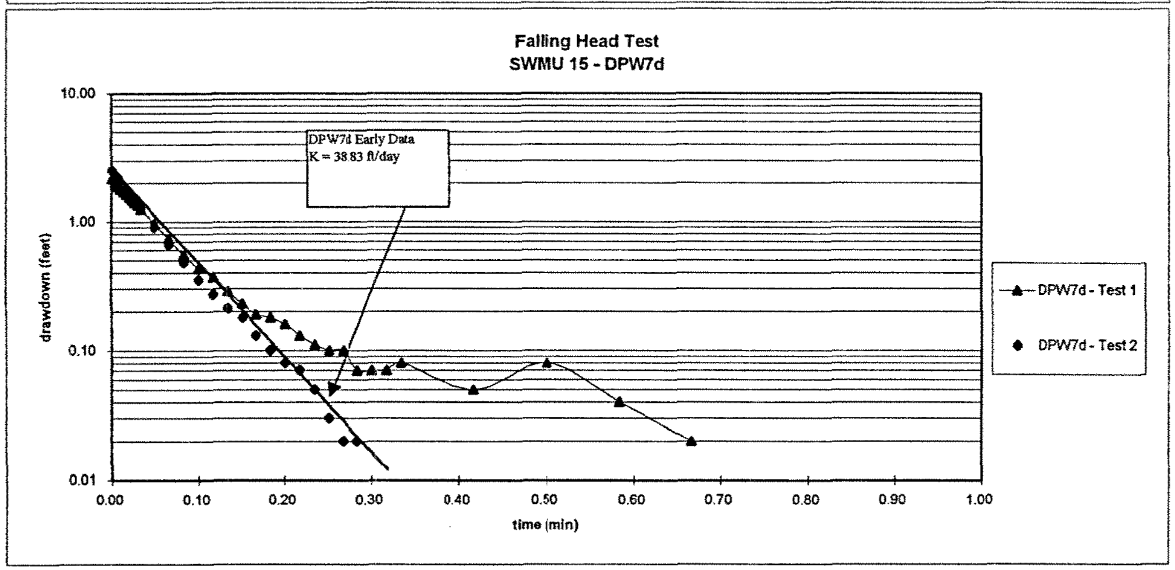


FIGURE 7-3

AQUIFER TEST COMPARISON - SWMU 15 DPW7d / MW7d

BOUWER AND RICE DATA PLOTS

ADDITIONAL ASSESSMENT USING INNOVATIVE TECHNOLOGY

NAVSTA MAYPORT, FLORIDA

ICON

6160 Perkins Road Suite 100 Baton Rouge, LA 70808

(504) 769-2073 fax (504) 761-4489

File Name: FIG-ST		**Date:**	Jan 98
Project Number: data\navy\d-report		**Source:**	ICON, 1998

SECTION 8

IMPLEMENTATION / COST COMPARISON

8.0 IMPLEMENTATION/COST COMPARISON

8.1 IMPLEMENTATION

8.1.1 IMPLEMENTATION OF DIRECT PUSH WELLS AT SWMU-15

Eighteen (18) direct push monitor wells (DPWs) were installed at the SWMU-15 area. DPW screened intervals were set at three depths, generally at (3 to 8 feet), (10 to 15 feet) and (27 to 32 feet) below land surface (bls).

In general, all DPWs were installed by pushing the drive assembly into the subsurface using the weight of the drill rig applied by the rig hydraulics (advanced by pushing). In denser sands, hammering utilizing a 4" downhole air hammer supplied by the rig air compressor advanced the drive assembly. A sub connection at the top of the drive assembly transferred the hammer energy to the drive assembly (Photograph 10).

Six (6) DPWs (*DPW1s* through *DPW6s*) were screened (from 3 to 8 feet bls) to straddle the water table. The drive assembly for each advanced by pushing 7.5 feet. The outer screens and PVC drive cones were seated by hammering with the drop rods from 7.5 feet to 8 feet bls. Due to the shallow nature of the screened interval only one DPW (*DPW3s*) was set by the "push-push" technique in which the drive assembly was driven to 1.5 feet bls and the outer screen and PVC drive cone was hammered out to 8 feet bls.

Five (5) *DPWs (DPW1i, DPW3i – DPW6i)* were screened (from 10 to 15 feet bls) in the second water bearing zone. The drive assembly for each was advanced by pushing to approximately 8.5' bls. Each DPW well screen was set utilizing the "push-push" technique, by hammering the outer screens and PVC drive cones to 6.5 feet below the drive assembly using steel drop rods.

Seven (7) DPWs (*DPW1d – DPW7d*) were screened with five foot long screens (depths ranging from (22 to 31 feet bls) in the third water bearing zone. The drive assembly *for DPW1d, DPW3d,* and *DPW6d* was advanced by pushing to approximately 1.5 feet above the target screened interval. The drive assembly for *DPW2d, DPW4d, DPW5d* and *DPW7d* was advanced by hammering to approximately 1.5 feet above the target screened interval. The screens of all seven of the deep DPWs were set utilizing the "push-push technique, hammering out the outer screen to 6.5 feet below the drive assembly. Furthermore, direct push wells *DPW2d, DPW4d, DPW5d* and *DPW7d* were installed with a carbon steel drive cone used to replace the originally proposed PVC cones due to structural failure of one PVC cone upon descent in dense sands.

All of the direct push wells were successfully installed with the exception of DPW5d in which the Teflon™ packer seal had slipped and moved up during installation thereby allowing the cement/bentonite grout slurry to enter the screen interval. The original DPW5d was plugged and abandoned and replaced with an adjacent successful direct push well installation.

8.1.2 IMPLEMENTATION OF DIRECT PUSH WELLS AT BUILDING 191

Twenty-four (24) direct push monitor wells (DPWs) were installed at Building 191. Screened intervals were designed based on the depth of clay layers as determined from geophysical logging. Nested DPWs with two to four screened intervals were installed at each location. The well designations *s,i,d* refer only to the relative screened depth at a particular well cluster, and do not indicate an absolute depth of the screened interval. For example, the zone in which DPW9s is screened correlates to DPW2d.

Because the subsurface sands are dense to very dense at Building 191, all the drive assembly for all DPWs was advanced by was hammering into the subsurface utilizing a 4" downhole air hammer supplied by the rig air compressor. A sub connection at the top of the drive assembly transferred the hammer energy to the drive assembly (Photograph 10).

Five (5) DPWs (*DPW1s – DPW4s* and *DPW6s*) were screened (from 3 to 8 feet bls) to straddle the water table, herein denoted as the top of the "A" Zone. The drive assembly was advanced by hammering to approximately 7.5' bls. The outer screens were seated by hammering with the drop rods from 7.5' to 8' bls. The drive assembly was then withdrawn while holding the DPW riser in place. Due to the shallow depth of groundwater occurrence, all of these shallow DPWs screens were set by this "push-retract" technique. All of the wells were set utilizing the proposed PVC drive cones.

Two (2) DPWs (*DPW7s* and *DPW8s*) were screened (from 10 to 15 feet bls) near the upper portion of the "A" Zone, below the top of the water table. The drive assembly of each was advanced by hammering to approximately 8.5' bls. Each DPW screen was set utilizing the "push-push" technique, hammering the outer screens and carbon steel drive cones 6.5' below the drive assembly using the steel drop rods.

Two (2) DPWs (*DPW2i* and *DPW4i*) wells were screened (from 17 to 22 feet bls) in the middle of the first water bearing zone (mid- "A" Zone). The drive assembly for each was advanced by hammering to approximately 15.5' bls. Each DPW well screen was set utilizing the "push-push" technique, hammering the outer screen and carbon steel drive cone to 6.5 feet below the drive assembly using the drop rods. The initial installation of DPW2i failed when the drive cone sheared off the outer screen and allowed formation sand to enter the screen, thereby preventing the packer seal from seating properly. Cement slurry entered the screen. The original DPW was grouted in place, and an adjacent replacement well was installed using the "push-retract" technique.

Two (2) DPWs (*DPW3i* and *DPW6i*) wells were screened (from 22 to 27 feet bls) at or near the lower-middle portion of the first water bearing zone ("A" Zone). The drive assembly for each was hammered to approximately 20.5 feet bls. Each DPW screen was set utilizing the "push-push" technique, hammering the outer screens and steel drive cone to 6.5 feet below the drive assembly using the drop rods. However, DPW6i was partially hammered out to 5 feet below the drive assembly before refusal was encountered.

Six (6) DPWs (*DPW2d, DPW4d, DPW5i, DPW7i, DPW8i, and DPW9s*) were constructed with five foot screens (ranging at depths of 26 to 32.5 feet bls) at the base of Zone "A". The drive assembly for *DPW4d, DPW8i* and *DPW9s* was hammered to approximately 1.5 feet above the target screened interval, and the screens were set utilizing the "push-push" technique, hammering out the outer screens and steel drive cones to 6.5 feet below the drive assembly. The drive assembly for remaining DPWs in this zone was hammered to 0.5 feet above the base of the target screened interval. The outer screens were then hammered to 0.5 feet below the drive assembly to seat the screen, and retracting the drive assembly completed installation.

Three (3) DPWs (*DPW1d, DPW3d*, and *DPW9i*) were screened (from 35 to 40 feet bls) in the second water bearing zone denoted in this report as the "B" Zone. The drive assembly for DPW1d was hammered to 33.5' bls, and the screen was set utilizing the "push-push" technique, hammering out the outer screen and steel drive cone to 6.5 feet below the drive assembly using drop rods. The drive assembly for DPW3d and DPW9i was hammered to approximately 39.5' bls, and the outer screens with steel drive cones were then hammered an additional 0.5 feet to seat the screen before retracting the drive assembly.

Four (4) DPWs (DPW3dd, DPW7d, DPW8d) wells were screened (from 42 to 47 feet bls) in the third water bearing zone denoted in this report as the "C" Zone. The drive assembly was hammered to 40.5' bls for direct push well 3dd, 7d and 8d. The direct push well installations were set utilizing the "push-push" technique, hammering the outer screens and steel drive cones to 6.5 feet below the drive assembly, with the exception of DPW3dd which was only extended out a total of 4.5 feet before refusal. The remaining DPW9d was hammered to 45.5 feet bls and the screen was set to 0.5 feet below the drive assembly before retracting the drive assembly.

Excessively dense sands required this use of the "push-retract" technique.

All of the direct push wells were successfully installed with the exception of DPW2i, which, during installation encountered refusal and the carbon steel drive cone sheared off after driving to 4.5 feet below the drive assembly. During installation of the 0.75" I.D. well screen and riser pipe, sand was discovered inside the outer screen, which caused poor sealing of the packer seal and the cement/bentonite grout slurry entered within the screen interval. The original DPW2i was plugged and abandoned and replaced with a successful direct push well installation.

The 5 shallow DPWs (3 – 8 ft bls) were installed using the "push retract" technique since the water table was relatively high in which the wells straddled. Seven of the 19 deeper wells were installed using the "push-retract" technique due to dense soils encountered upon hammering out the outer screens. Additionally three of the wells (DPW3dd, DPW6I, and DPW8d) had only been partially deployed with the drop rod because of refusal.

The Log of Boring Diagram for MW-07d indicates dense soils recorded in the range of 220 blows/ft to 300 blows/ft using a 140-lb. hammer for the ASTM standard penetration test. Soils with densities greater than 50 blows/ft caused the PVC drive cones and PVC outer screens to fail upon deployment.

Modifications of the (PVC) outer screen and drive cone or utilization of a different material (high density plastics or stainless steel) possibly would allow the outer screens structural integrity to penetrate subsurface soils denser than 50 blows/foot.

8.2 COST COMPARISON

The cost per monitor well is typically a function of the number of monitor wells installed during a single mobilization, subsurface conditions (dense vs. unconsolidated sediments, etc.), degree of contamination, etc. For the purposes of this cost comparison a per/well cost was prepared based on actual time required for well and DPW installation, and actual material costs. To reflect the differences in soil types encountered at SWMU-15 and Building 191, each site was calculated separately to derive costs at each site specific to well depths.

The average actual cost per hour for the drill crew, equipment and geologists was $210/hour. Excluded from the comparison are well purging and sampling time, and disposition of purge water. No soil cuttings are generated from DPW installation. No grossly contaminated soil or groundwater was encountered at either of the demonstration sites.

Worker exposures to hazardous wastes are lower for DPW installations because of the lack of cuttings to be managed, and less volume of purge water. Generally in contaminated sites that normally warrant Level B health and safety procedures, use of DPW technology allows Level C procedures. Sites containing hazardous conditions would increase the cost because of health and safety procedures and equipment. An estimate of additional costs per well assuming that each site was contaminated are included at the bottom of Tables 8-1 through 8-4.

Costs not included in the evaluation include well development time, disposition of purge water, and well sampling costs. The average time required for development of DPWs was 15 minutes, producing an average of 6 gallons per well of purge water. The average time for development of conventional wells was 35 minutes, producing an average of 41 gallons per well. Time requirements for sampling were slightly longer for conventional wells, because conventional wells required purging approximately twice the volume of purge water for stabilization of field parameters as compared to DPWs. Costs for disposition of purge water during the life of a long-term monitoring program are significant, but were not considered for this evaluation.

8.2.1 SWMU-15 COST COMPARISON

Unconsolidated sediments consisting of silty sands and silty clays underlie SWMU 15. Sediments exhibited results of standard penetration testing (ASTM) generally less than 30 blows per foot, with the exception of deeper intervals on the north side of the site where denser sands were encountered. Cost comparisons for shallow DPW and conventional wells at SWMU 15 are summarized on Table 8-1. The conventional wells were installed at the same depths as the shallow DPWs, screened at 3 to 8 feet bls. As can be seen on Table 8-1, costs for DPW installations were 54% of the cost per well for conventional well installations. If the site was contaminated (requiring more health and safety procedures and disposal of cuttings) the cost for DPW installations would have been approximately 27% the cost of conventional well installations.

Cost comparisons for deeper DPW and conventional wells at SWMU 15 are summarized on Table 8-2. The conventional wells were installed through surface isolation casing, screened at the same depths as the deep DPWs, at 23 to 28 feet bls. As can be seen on Table 8-2, costs for DPW installations were 28% of the cost per well for conventional well installations. If the site was contaminated (requiring more health and safety procedures and disposal of cuttings) the cost for DPW installations would have been approximately 14% the cost of conventional well installations.

8.2.2 BUILDING 191 COST COMPARISON

Building 191 is underlain by dense sands with some clay lenses with worm reef stringers. Sediments exhibited results of ASTM standard penetration testing with a 140-pound hammer commonly over 50 blows per foot, with some zones exceeding 250 blows per foot. Cost comparisons for shallow DPW and conventional wells at Building 191 are summarized on Table 8-3. The conventional wells were installed at the same depths as the shallow DPWs, screened at 10 to 15 feet bls. As can be seen on Table 8-3, costs for DPW installations were 45.1% of the cost per well for conventional well installations. If the site was contaminated (requiring more health and safety procedures and disposal of cuttings) the cost for DPW installations would have been approximately 19.5% the cost of conventional well installations.

Cost comparisons for deeper DPW and conventional wells at Building 191 are summarized on Table 8-4. The conventional wells were installed through surface isolation casing, screened at the same depths as the deep DPWs, at 27 to 32 feet bls. As can be seen on Table 8-4, costs for DPW installations were 24% of the cost per well for conventional well installations. If the site was contaminated (requiring more health and safety procedures and disposal of cuttings) the cost for DPW installations would have been approximately 9.5% the cost of conventional well installations.

TABLE 8-1
COST COMPARISON FOR DPW AND CONVENTIONAL WELLS
SWMU 15 SHALLOW WELLS

MATERIALS & INSTALLATION	DPW WELLS			CONVENTIONAL WELLS		
	RATE	QUANTITY	TOTAL	RATE	QUANTITY	TOTAL
Installation time	$210 /hour	0.19	$39.90	$210 /hour	0.5	105.00
Soil Management Time	N/A			$210 /hour	0.25	52.50
Screen	$11 /5ft	1	$11.00	$15 /5ft	1	15.00
DPW Outer Screen	$49 /each	1	$49.00	N/A		
Riser Pipe	$8 /5ft	1	$8.00	$10 /5ft	1	10.00
Packer Seal (Teflon)	$15 /seal	1	$15.00	N/A		
Plug	$4.50 /unit	1	$4.50	$5.00 /unit	1	5.00
Filter Sand	N/A			$8 /bag	5	40.00
Bentonite	$20 /50#	0.5	$10.00	N/A		
Bentonite Chips	N/A			$20 /50#	1	20.00
PVC Drive Cone	$17.81 /each	1	$17.81	N/A		
Steel Drive Cone	N/A			N/A		
Cement	$8 /bag		$0.00	$8 /bag	1	8.00
Drum for soil	N/A			$30 /drum	1	30.00
		Subtotal:	**$155.21**		***Subtotal:***	**$285.50**

ESTIMATED ADDITIONAL COSTS IF THE SITE WERE CONTAMINATED

	DPW WELLS			CONVENTIONAL WELLS		
	RATE	QUANTITY	TOTAL	RATE	QUANTITY	TOTAL
Soil Disposal	$550 /drum	0	$0.00	$550 /drum	1	550.00
Level B Health & Safety	$45 /man	3	$135.00	N/A		
Level C Health & Safety	N/A			$75 /hour	3	225.00
		Subtotal:	**$135.00**		***Subtotal:***	**$775.00**

TABLE 8-2
COST COMPARISON FOR DPW AND CONVENTIONAL WELLS
SWMU 15 DEEP WELLS

MATERIALS & INSTALLATION	DPW WELLS			CONVENTIONAL WELLS		
	RATE	QUANTITY	TOTAL	RATE	QUANTITY	TOTAL
Installation time	$210 /hour	0.5	$105.00	$210 /hour	1.85	388.50
Soil Management Time	N/A			$210 /hour	0.65	136.50
Surface Casing (8")	N/A			$70 /10ft	1	70.00
Screen	$11 /5ft	1	$11.00	$15 /5ft	1	15.00
DPW Outer Screen	$49 /each	1	$49.00	N/A		
Riser Pipe - 5 ft joint	$8 /each	1	$8.00	$10 /each	1	10.00
Riser Pipe - 10 ft joint	$10 /each	2	$20.00	$15 /each	2	30.00
Packer Seal (Teflon)	$15 /seal	1	$15.00	N/A		
Bottom Plug	$4.50 /unit	1	$4.50	$5.00 /unit	1	5.00
Filter Sand	N/A			$8 /bag	5	40.00
Bentonite	$20 /50#	0	$0.00	N/A		
Bentonite Chips	N/A			$20 /50#	1	20.00
PVC Drive Cone	$17.81 /each	1	$17.81	N/A		
Volclay	$24.00 /bag	0.1	$2.40	N/A		
Steel Drive Cone	N/A			N/A		
Cement	$8 /bag	1	$8.00	$8 /bag	6	48.00
Drum for soil	N/A			$30 /drum	3	90.00
		Subtotal:	**$240.71**		***Subtotal:***	**$853.00**

ESTIMATED ADDITIONAL COSTS IF THE SITE WERE CONTAMINATED

	DPW WELLS			CONVENTIONAL WELLS		
	RATE	QUANTITY	TOTAL	RATE	QUANTITY	TOTAL
Soil Disposal	$550 /drum	0	$0.00	$550 /drum	3	1,650.00
Level B Health & Safety	$45 /man	3	$135.00	N/A		
Level C Health & Safety	N/A			$75 /hour	3	225.00
		Subtotal:	**$135.00**		***Subtotal:***	**$1,875.00**

TABLE 8-3
COST COMPARISON FOR DPW AND CONVENTIONAL WELLS
BUILDING 191 SHALLOW WELLS

MATERIALS & INSTALLATION	DPW WELLS			CONVENTIONAL WELLS		
	RATE	QUANTITY	TOTAL	RATE	QUANTITY	TOTAL
Installation time	$210 /hour	0.38	$79.80	$210 /hour	1.1	231.00
Soil Management Time	N/A			$210 /hour	0.35	73.50
Screen	$11 /5ft	1	$11.00	$15 /5ft	1	15.00
DPW Outer Screen	$49 /each	1	$49.00	N/A		
Riser Pipe	$10 /10ft	1	$10.00	$15 /10ft	1	15.00
Packer Seal (Teflon)	$15 /seal	1	$15.00	N/A		
Plug	$4.50 /unit	1	$4.50	$5.00 /unit	1	5.00
Filter Sand	N/A			$8 /bag	5	40.00
Bentonite	$20 /50#		$0.00	N/A		
Bentonite Chips	N/A			$20 /50#	1	20.00
PVC Drive Cone	N/A			N/A		
Volclay	$24.00 /each	0.1	$2.40	N/A		
Steel Drive Cone	$30.00 /each	1	$30.00	N/A		
Cement	$8 /bag	2	$16.00	$8 /bag	3	24.00
Drum for soil	N/A			$30 /drum	2	60.00
		Subtotal:	**$217.70**		***Subtotal:***	**$483.50**

ESTIMATED ADDITIONAL COSTS IF THE SITE WERE CONTAMINATED

	DPW WELLS			CONVENTIONAL WELLS		
	RATE	QUANTITY	TOTAL	RATE	QUANTITY	TOTAL
Soil Disposal	$550 /drum	0	$0.00	$550 /drum	2	1,100.00
Level B Health & Safety	$45 /man	3	$135.00	N/A		
Level C Health & Safety	N/A			$75 /hour	3	225.00
		Subtotal:	**$135.00**		***Subtotal:***	**$1,325.00**

TABLE 8-4
COST COMPARISON FOR DPW AND CONVENTIONAL WELLS
BUILDING 191 DEEP WELLS

MATERIALS & INSTALLATION	DPW WELLS			CONVENTIONAL WELLS		
	RATE	QUANTITY	TOTAL	RATE	QUANTITY	TOTAL
Installation time	$210 /hour	0.75	$157.50	$210 /hour	2.96	621.60
Soil Management Time	N/A			$210 /hour	1	210.00
Surface Casing (8")	N/A			$70 /10ft	2	140.00
Screen	$11 /5ft	1	$11.00	$15 /5ft	1	15.00
DPW Outer Screen	$49 /each	1	$49.00	N/A		
Riser Pipe - 5 ft joint	$8 /each	2	$16.00	$10 /each	2	20.00
Riser Pipe - 10 ft joint	$10 /each	2	$20.00	$15 /each	2	30.00
Packer Seal (Teflon)	$15 /seal	1	$15.00	N/A		
Bottom Plug	$4.50 /unit	1	$4.50	$5.00 /unit	1	5.00
Filter Sand	N/A			$8 /bag	5	40.00
Bentonite	$20 /50#	0	$0.00	N/A		
Bentonite Chips	N/A			$20 /50#	1	20.00
Steel Drive Cone	$30.00 /each	1	$30.00	N/A		
Volclay	$24.00 /bag	0.1	$2.40	N/A		
Steel Drive Cone	N/A			N/A		
Cement	$8 /bag	3	$24.00	$8 /bag	9	72.00
Drum for soil	N/A			$30 /drum	6	180.00
		Subtotal:	**$329.40**		***Subtotal:***	**$1,353.60**

ESTIMATED ADDITIONAL COSTS IF THE SITE WERE CONTAMINATED

	DPW WELLS			CONVENTIONAL WELLS		
	RATE	QUANTITY	TOTAL	RATE	QUANTITY	TOTAL
Soil Disposal	$550 /drum	0	$0.00	$550 /drum	6	3,300.00
Level B Health & Safety	$45 /man	3	$135.00	N/A		
Level C Health & Safety	N/A			$75 /hour	3	225.00
		Subtotal:	**$135.00**		***Subtotal:***	**$3,525.00**

APPENDIX A

PHOTODOCUMENTATION

PHOTO NO.1

OUTER SCREEN (1.25-INCH ID; 1.7-INCH OD); PVC CONE FOR UNCONSOLIDATED SEDIMENTS, STAINLESS STEEL CONE FOR DENSE SANDS. NOTE STAGGERED 0.008-INCH SLOTS.

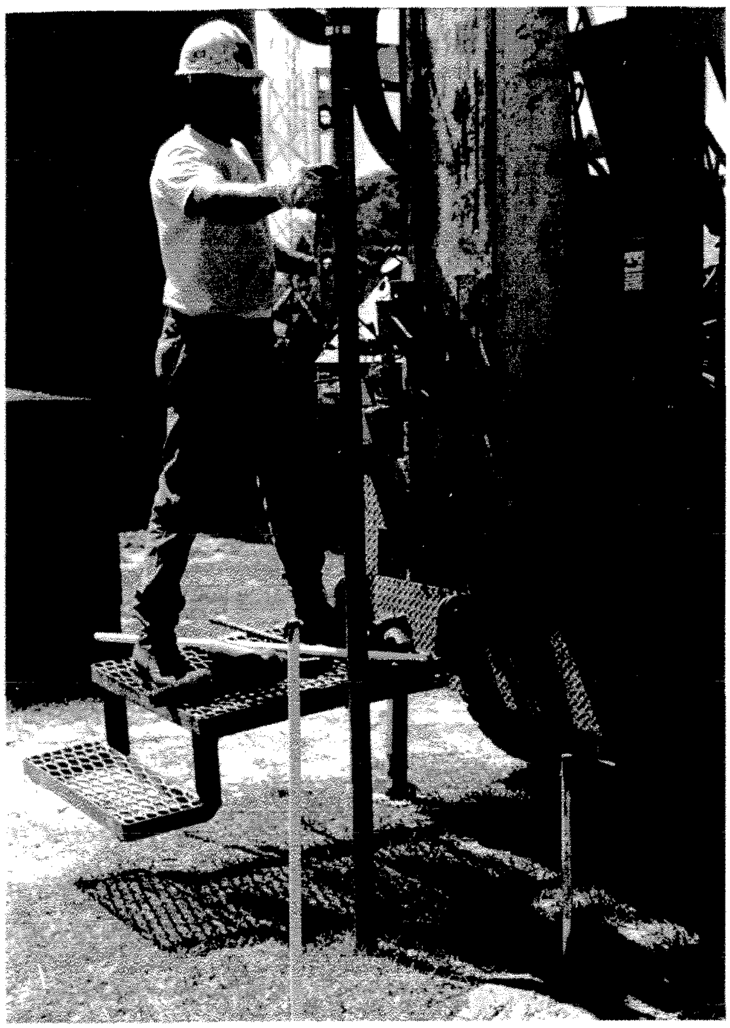


PHOTO NO.2

DRIVE CASING SEATED TO ONE FOOT BELOW LAND SURFACE, OUTER SCREEN INSIDE CASING (OUT OF VIEW). SUB AT TOP OF CASING ATTACHES TO DRILLING RIG HYDRAULICS (HEX CONNECTION) READY FOR PUSHING.

NOTE TWO ADJACENT DPWs JUST INSTALLED, GROUT CURING

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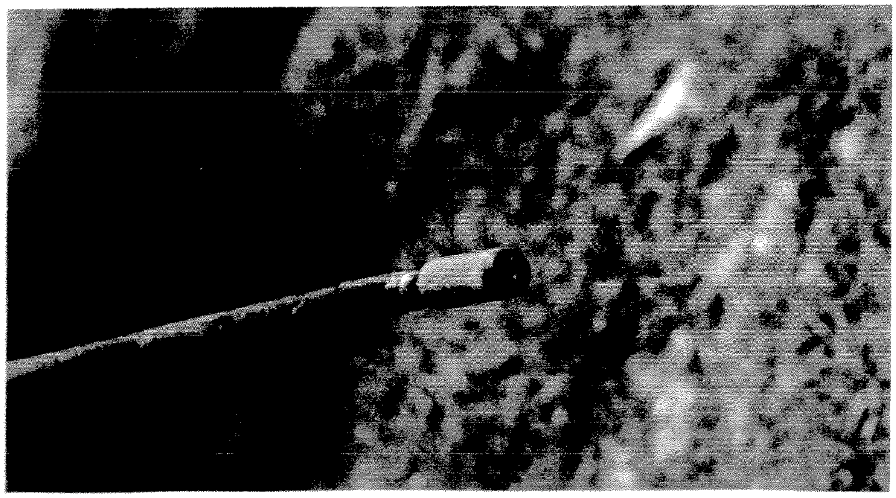

PHOTO NO.3

CLOSE UP VIEW OF THE BASE OF THE DROP RODS USED TO HAMMER OUT THE CONE AND OUTER SCREEN

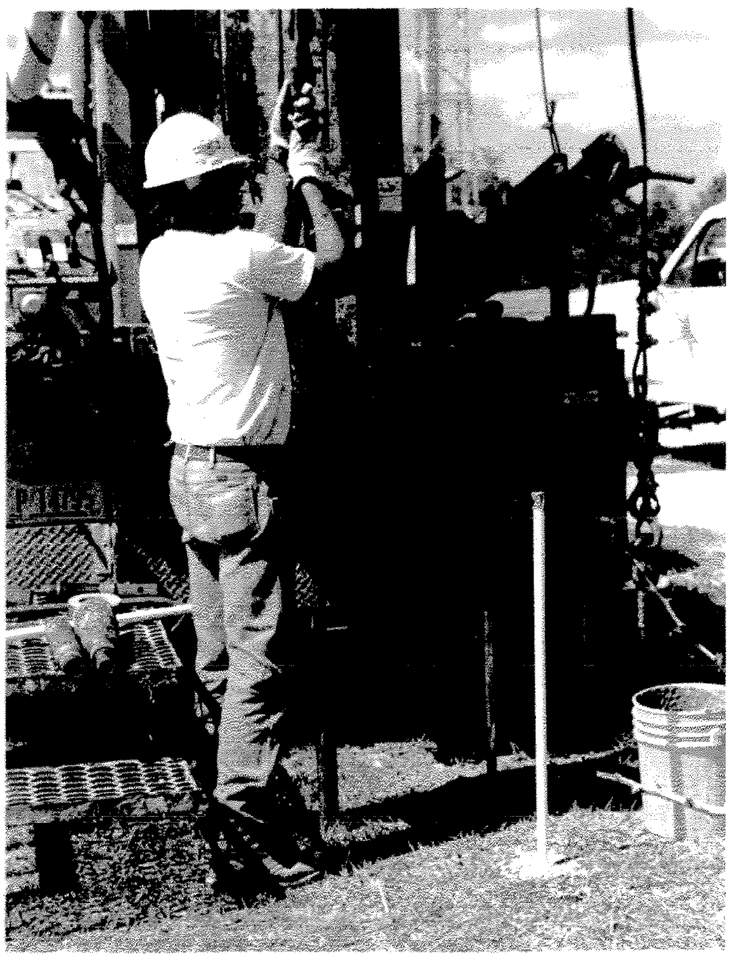

PHOTO NO.4

PROCESS OF HAMMERING OUT THE OUTER SCREEN WITH THE DROP ROD ASSEMBLY

ICON
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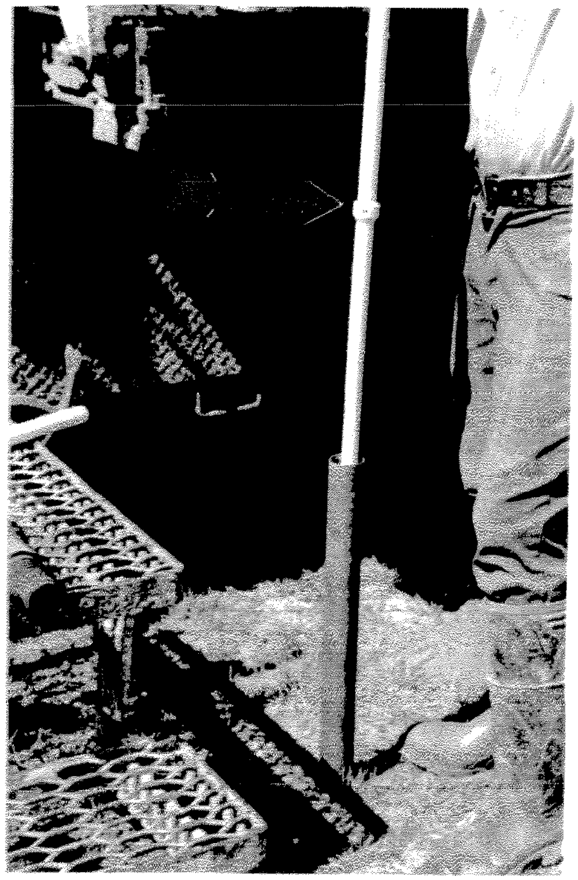

PHOTO NO. 5

INSERTION OF THE INNER SCREEN (3/4-INCH DIAMETER) THROUGH THE DRIVE CASING AND INTO THE OUTER SCREEN; NOTE THE TEFLON PACKER THAN SEATS ONTO THE TOP CIRCUMFERENCE OF THE OUTER SCREEN IN THE DRIVE SHOE. THE PACKER PREVENTS GROUT FROM ENTERING THE SCREEN.

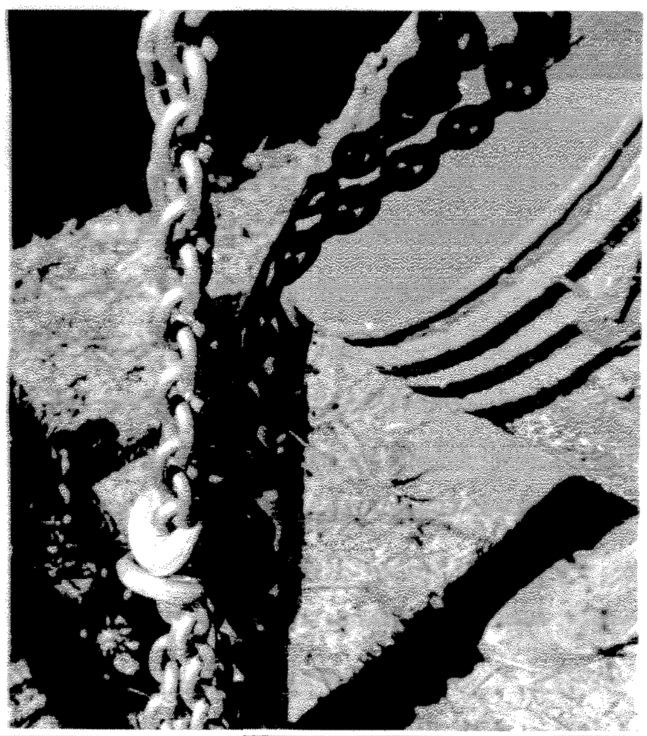

PHOTO NO.6

A TEMPORARY WELL CAP IN PLACED ON THE INNER SCREEN RISER (OUT OF VIEW) AND A SLUG OF VOLCLAY™ IS POURED INTO THE DRIVE ASSEMBLY WITH THE INNER SCREEN IN PLACE (OUT OF VIEW IN THIS PHOTO). THE VOLCLAY IS ALLOWED TO SET, AND GROUT IS POURED WHILE THE DRIVE ASSEMBLY IS LIFTED WHILE HOLDING THE INNER SCREEN RISER IN PLACE.

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PHOTO NO. 7

THE DRIVE ASSEMBLY IS LIFTED WITH THE RIG HYDRAULICS WHILE THE INNER SCREEN RISER IS HELD IN PLACE. GROUT (NOTE BUCKETS) IS POURED INTO THE DRIVE ASSEMBLY WHILE REMOVING.

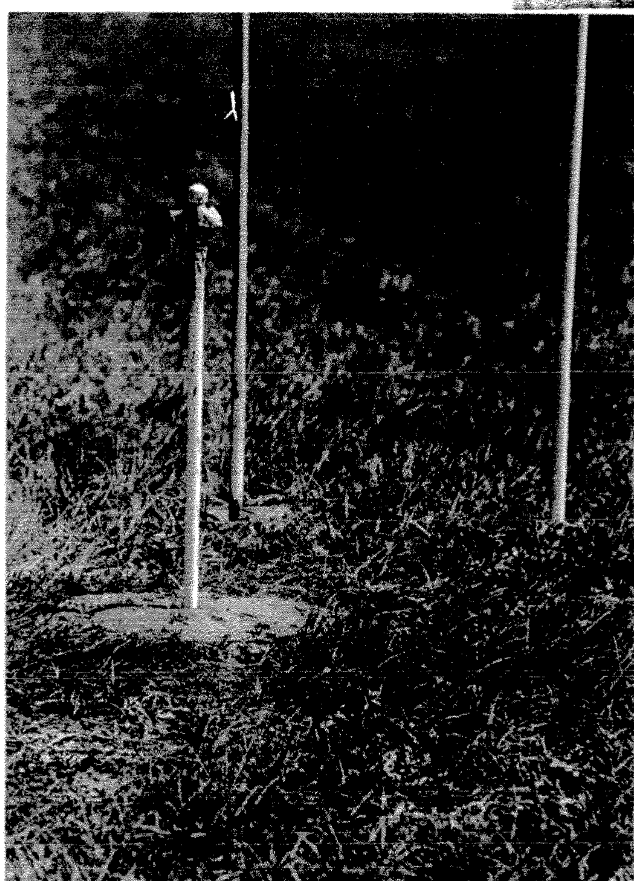

PHOTO NO.8

A WELL CLUSTER UPON COMPLETION OF INSTALLATION. GROUT IS ALLOWED TO CURE BEFORE SURFACE COMPLETIONS ARE CONSTRUCTED.

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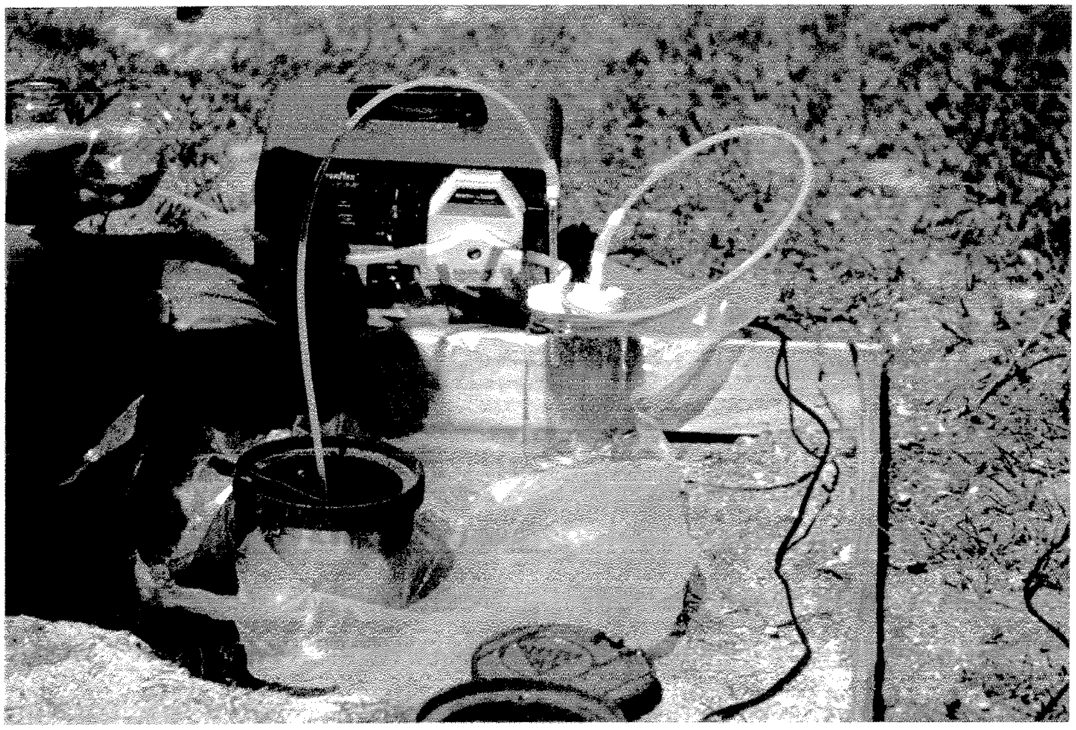

PHOTO NO.9

DEDICATED TEFLON TUBING IS PLACED IN THE WELL. THE WELL IS DEVELOPED AND PURGED USING A PERISTALTIC PUMP WHICH CREATES A VACUUM IN THE GLASS DROP OUT VESSEL.

PHOTO NO.10

AN AIR HAMMER ON THE GUS PECH DRILLING RIG WAS USED TO ADVANCE THE DRIVE ASSEMBLY IN DENSE SANDS. A SACRIFICIAL SUB WAS USED TO PREVENT DAMAGE TO THE PRIMARY SUB CONNECTION OF THE DRIVE ASSEMBLY.

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