Fort Wingate Depot Activity

Monitoring Well Installation and

Abandonment Work Plan

Fort Wingate Depot Activity
McKinley County, New Mexico

April 12, 2011

MIPR W45XMA10567165

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1.0 INTRODUCTION

Fort Wingate Depot Activity (Ft. Wingate) occupies approximately 24 square miles (15,300 acres) in northwestern New Mexico (Figure 1). It is located in McKinley County approximately 6 miles east of Gallup, NM and 130 miles west of Albuquerque, NM. Until 1993, Ft. Wingate was used by the U.S. Army as a transportation hub for material goods, the maintenance and disposal of aging or outdated munitions, and the refurbishment of small arms ammunition. Fort Wingate was decommissioned in January 1993 and currently (2011) is undergoing environmental investigation and restoration in preparation for transfer of parts of the property to the Department of the Interior.

Ft. Wingate was established as a cavalry outpost in 1860 under the name Fort Fauntleroy. It has been assigned several different names throughout its history. Ft. Wingate was abandoned during the Civil War then reoccupied in 1868, and has remained an important post throughout the 20th century (Heckert and others, 2003). The U.S. Army Ordnance Department took command of Ft. Wingate in 1918 and by 1920, it was the largest storage facility of munitions in the world (Heckert and others, 2003). The primary mission from this period forward was munitions storage, but it has also been used for rocket testing including the Pershing missile system. In addition to the ongoing Army environmental and caretaker activities, a large portion of the property is used by the Missile Defense Agency to conduct Theater Missile Defense Program testing and several buildings are leased to the U.S. Department of Agriculture for storing packaged food items for the benefit of the Navajo Nation.

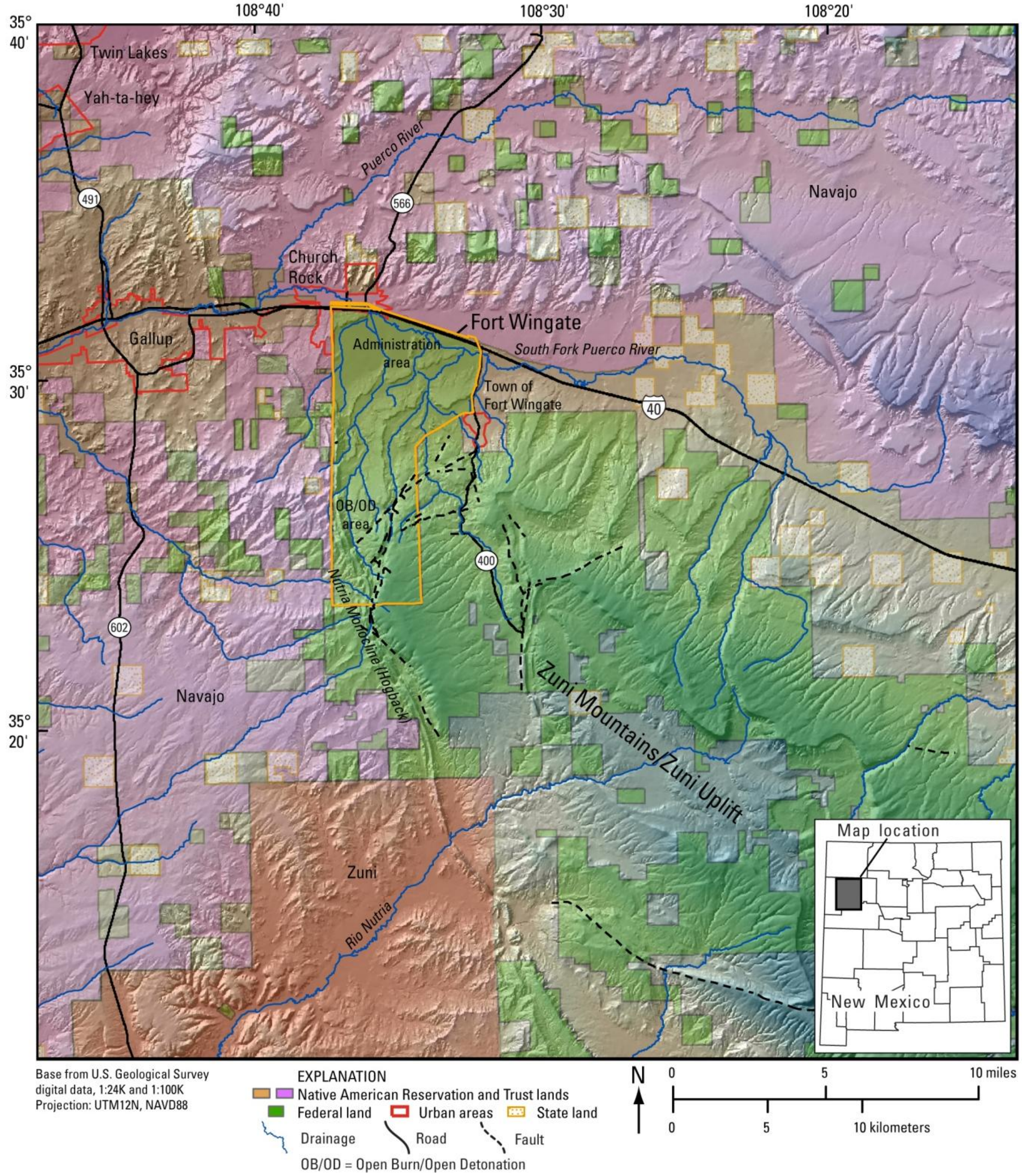


Figure 1: Location of Fort Wingate Depot Activity, NM

Facilities at Ft. Wingate include approximately 500 concrete bunkers located throughout the post, two former open burn and open detonation (OB/OD) areas, a workshop area, and various mission-support service structures located in the administration area (Figure 1). As part of the preparation for transfer, Resource Conservation and Recovery Act (RCRA)-driven investigations have identified groundwater within the Administrative and Workshop Areas with concentrations of explosive compounds, perchlorate and nitrates exceeding regulatory standards. Results of these studies have suggested the compounds are migrating northward in the shallow alluvial aquifer along the local groundwater gradient toward the northern boundary of Fort Wingate (TerranearPMC, 2006).

1.1 Purpose and Scope

The purpose of this Work Plan is to describe the work to be performed by the U.S. Geological Survey (USGS) on behalf of the U.S. Army Corps of Engineers, Fort Worth District (USACE) as part of the environmental restoration program at Fort Wingate Depot Activity (FWDA), NM. The work described in this plan covers the installation of up to 18 groundwater monitoring wells and the abandonment of 10 groundwater monitoring wells at FWDA. This work will serve to further delineate groundwater contaminant plumes, establish background concentration levels, monitor potential off-site migration, and remove from service several dry monitoring wells. All work will be executed in accordance with standard procedures and requirements described in New Mexico Administrative Code (NMAC) 19.27.4 and under the guidance of the RCRA permit Number NM 6213820974.

2.0 BACKGROUND

2.1 CLIMATE

The climate of the region is arid to semi-arid, and precipitation has averaged 11.9 inches at Ft. Wingate (1940 to 1966), 11.3 inches at Gallup (1921 to 2005), and 18.7 inches at McGaffey (1923 to 2005) in the Zuni Mountains (Western Regional Climate Center, 2010). A majority of precipitation occurs during the monsoon season (late summer and early fall), although the slow-release of spring snowmelt provides for higher infiltration compared to the intense monsoon thunderstorms (Anderson and others, 2003). This climate supports a ponderosa pine and mixed fir forest above 7,500 feet (ft), and piñon and juniper forests from 7,500 to 6,800 ft. At lower elevations, shrubs and grasses predominate.

2.2 GEOLOGY

2.2.1 SURFACE AND STRUCTURAL GEOLOGY

Ft. Wingate lies on the northwest apex of the Zuni Uplift (Figure 2). The Zuni uplift is a broad asymmetric anticline, which plunges north-northwest. While the Zuni uplift likely has a compound tectonic history, its present configuration developed during the Laramide orogeny that took place approximately 75 to 35 million years ago (mya). This uplift tilted the bedrock underlying the majority of FWDA to the northwest at an angle of approximately 5 degrees (Lorenz and Cooper, 2001). The majority of post activity took place on the moderately incised dip slopes of the uplifted claystones and sandstones of the Triassic Chinle Group. In the higher elevations to the south, the uplift has exposed older sedimentary sequences of Permian age (Figure 2). Precambrian granite rocks, overlain by the Permian and Triassic units on the northern dip slope are exposed south of the facility.

The dominant topographic and structural feature at Ft. Wingate is the Nutria monocline, known locally as “the hogback”. The hogback is a north-northwest to south-southeast trending monocline that dips steeply to the south-southwest and defines the west and southwest margin of the Zuni uplift. The hogback rises as much as 2,000 ft above the surrounding area, and dips commonly exceed 60° (Anderson and others, 2003).

The northern boundary of FWDA terminates in the strike valley of the South Fork Puerco River. The valley represents the transition between the Zuni uplift to the south and the Chaco slope to the north. The Chaco slope is a gently north-dipping slope between the Zuni uplift and the inner San Juan basin (Lorenz and Cooper, 2001).

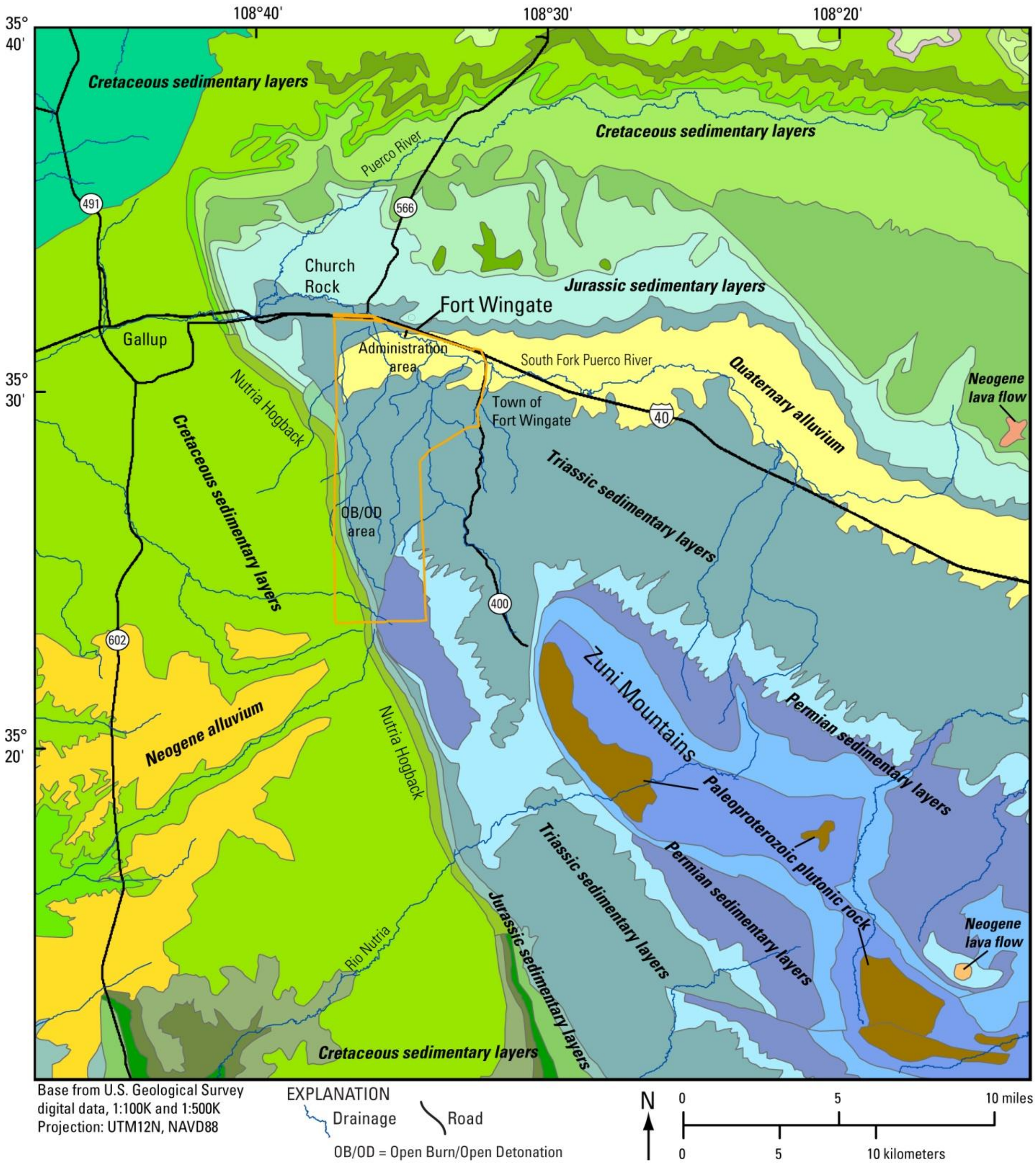
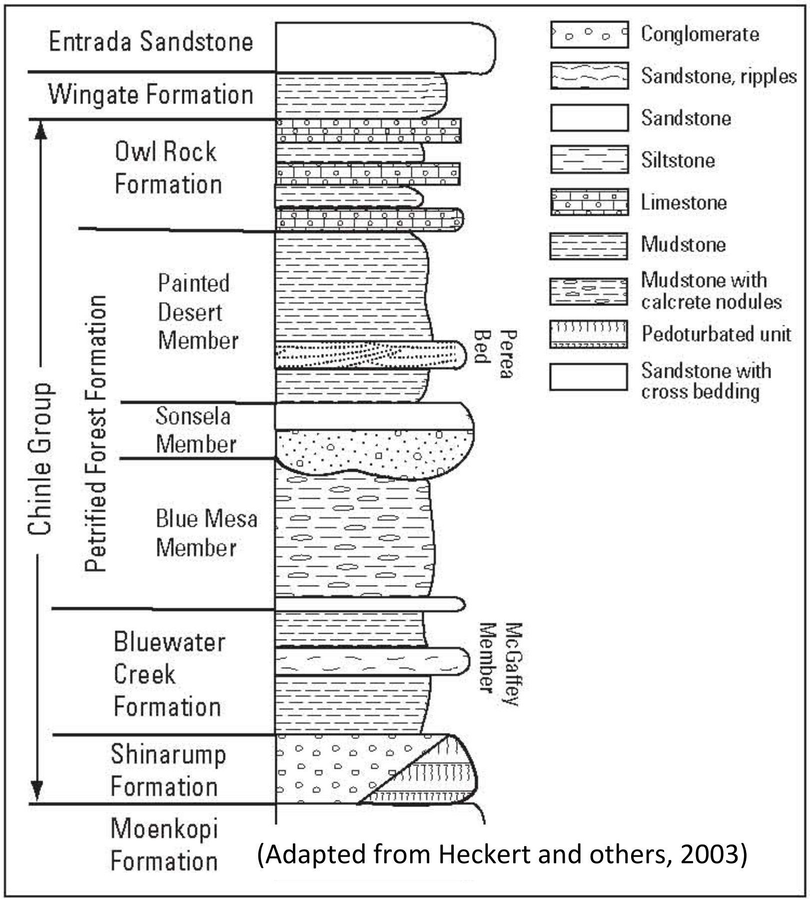


Figure 2: Surface Geology of Ft. Wingate Region

2.2.2 SUBSURFACE STRUCTURAL GEOLOGY

The surface geology of the administration and workshop areas is quaternary alluvium and outcrops of the Triassic-age Chinle group. The Petrified Forest Formation, of the upper Chinle group, comprises more than 75 percent of the bedrock exposures throughout Ft. Wingate. The interbedded claystone and sandstone units of the Petrified Forest Formation underlie the unconsolidated quaternary deposits. The Chinle is composed of nonmarine red-bed siliciclastics, and unconformably overlies the siltstone and claystone of the Middle Triassic age Moenkopi (Anderson and others, 2003). The siltstone and claystone of the Moenkopi, which unconformably overlie San Andres Limestone of Permian age (Figure 3), act as a barrier to vertical flow inducing artesian conditions in the San Andres (Callahan and Cushman, 1954).



(Adapted from Heckert and others, 2003)

Figure 3: Geologic Stratigraphy Column

2.3 HYDROGEOLOGY

The shallow alluvial aquifer is composed of recent unconsolidated sediments consisting primarily of silts and clays. The unconsolidated material ranges in thickness from 0 ft in parts of the workshop area to 85 ft near the Puerco River and depths to water range from 15 ft to 65 ft. Depositional environments created a discontinuous and intertonguing lithology. The bedrock underlying the shallow alluvial aquifer is composed of Triassic age mudstone and claystone with intermittent sandstone units of the Painted Desert. Saturated conditions have been found in these sandstone units and are under confined conditions due to the surrounding claystone units.

There are two additional minor, water-yielding members of the Chinle formation: the Shinarump Conglomerate and the Sonsella Sandstone. Water yields from the Shinarump and Sonsella generally yield 5 to 50 gallons per minute (gpm) and the water quality is considered fair to poor (Errol Montgomery & Associates, Inc, 2003) . The Sonsella is generally less than 100 ft thick and is approximately 400 ft below ground surface (bgs) in the study area.

The San Andres-Glorieta aquifer is principle aquifer for the post and surrounding communities. The aquifer is 1,100 ft deep and 200 ft thick where the post production well is located. In 1967 the well flowed to the land surface at a rate of 90 gpm (Shomaker, 1971).

3.0 SITE SELECTION FOR MONITORING WELLS

Proposed well locations were selected to address one of the following three objectives. The first objective is to monitor potential off-site migration of chemical constituents originating from former post activities. The second objective is to determine background concentrations of major and trace metals. The third objective is to add sufficient spatial data to further define the RDX, nitrate and perchlorate groundwater plumes. Approval from the USACE and NMED will be sought prior to changing the proposed well locations, due to field observations and findings.

3.1 SENTINEL MONITORING WELLS

Two Sentinel monitoring wells will be installed in Phase 1 (summer of 2011) of this project at the request of the New Mexico Environment Department (NMED). Two sites in the northwest portion of the post were selected to monitor potential off-site migration of chemical constituents in groundwater through the installation of two alluvial sentinel wells, MW23 and MW24 (Figure 4). The sites were chosen based on their close proximity to the Navajo Tribal Utility Authority (NTUA) alluvial water supply well NTUA 16T602. MW23 and MW24 will be drilled to the same depth as NTUA 16T602.

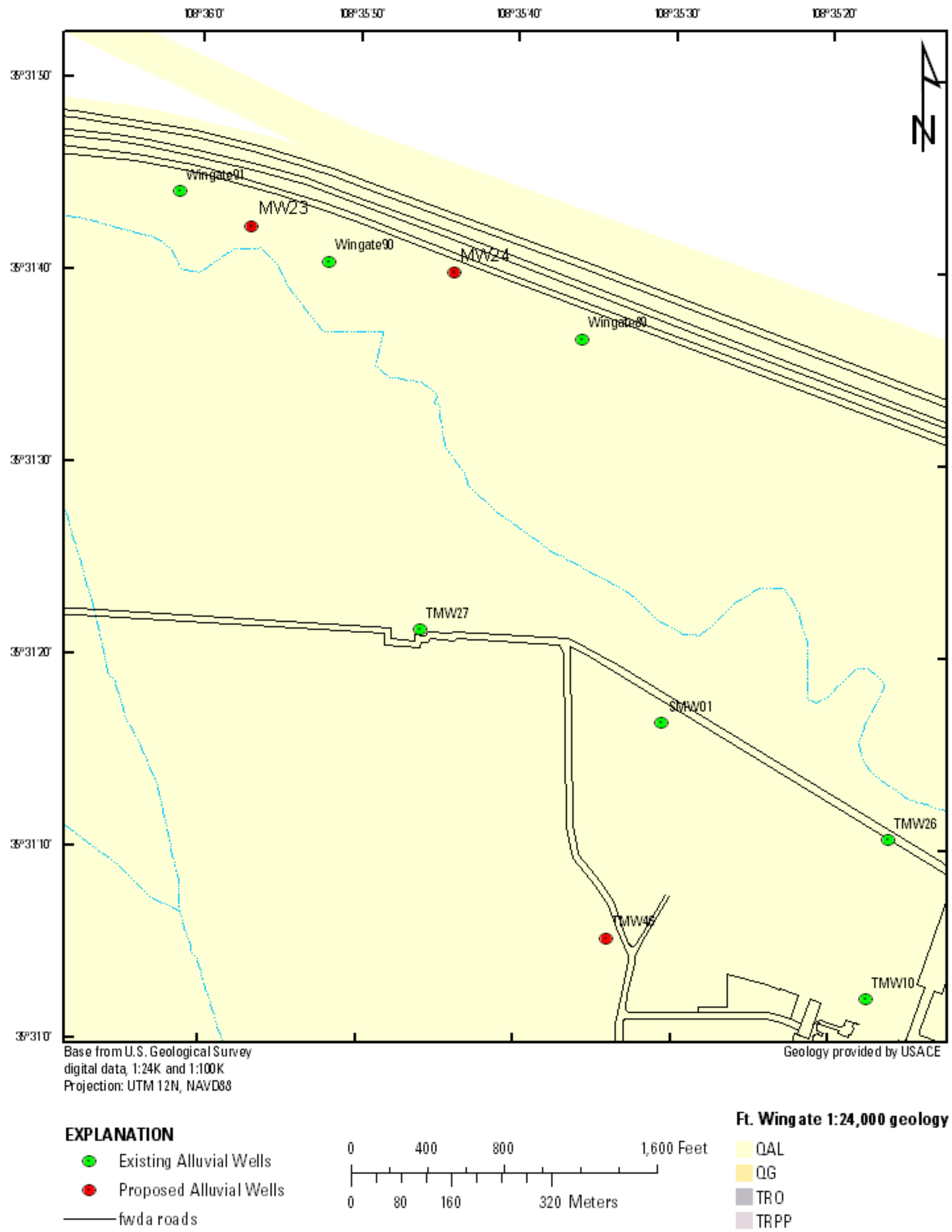


Figure 4: Sentinel Well Locations

3.2 BACKGROUND WELLS

Four background monitoring wells will be installed in Phase 2 (summer of 2012) of this project. Four sites were selected to determine the background concentrations of major and trace metals in the groundwater through the installation of alluvial wells BGMW01, BGMW02, BGMW03, and BGMW04 (Figure 5). Background concentrations reflect the naturally-occurring water-rock interactions for the local formation, as well as atmospheric inputs, clay mineralogy, water pH, and water chemistry.

Historical records, site investigations, and groundwater flow patterns suggest that groundwater at these proposed sites have not been affected by past post activities. Two background sites were chosen on the north side of the post where the groundwater hydraulic gradient has been interpolated to be higher than the impacted wells in the administration area. Two background sites were selected in the northwest portion of Ft. Wingate, to the east of Igloo Block A. The hydraulic gradient cannot be determined at this time, but is expected to slope towards the north (Figure 5).

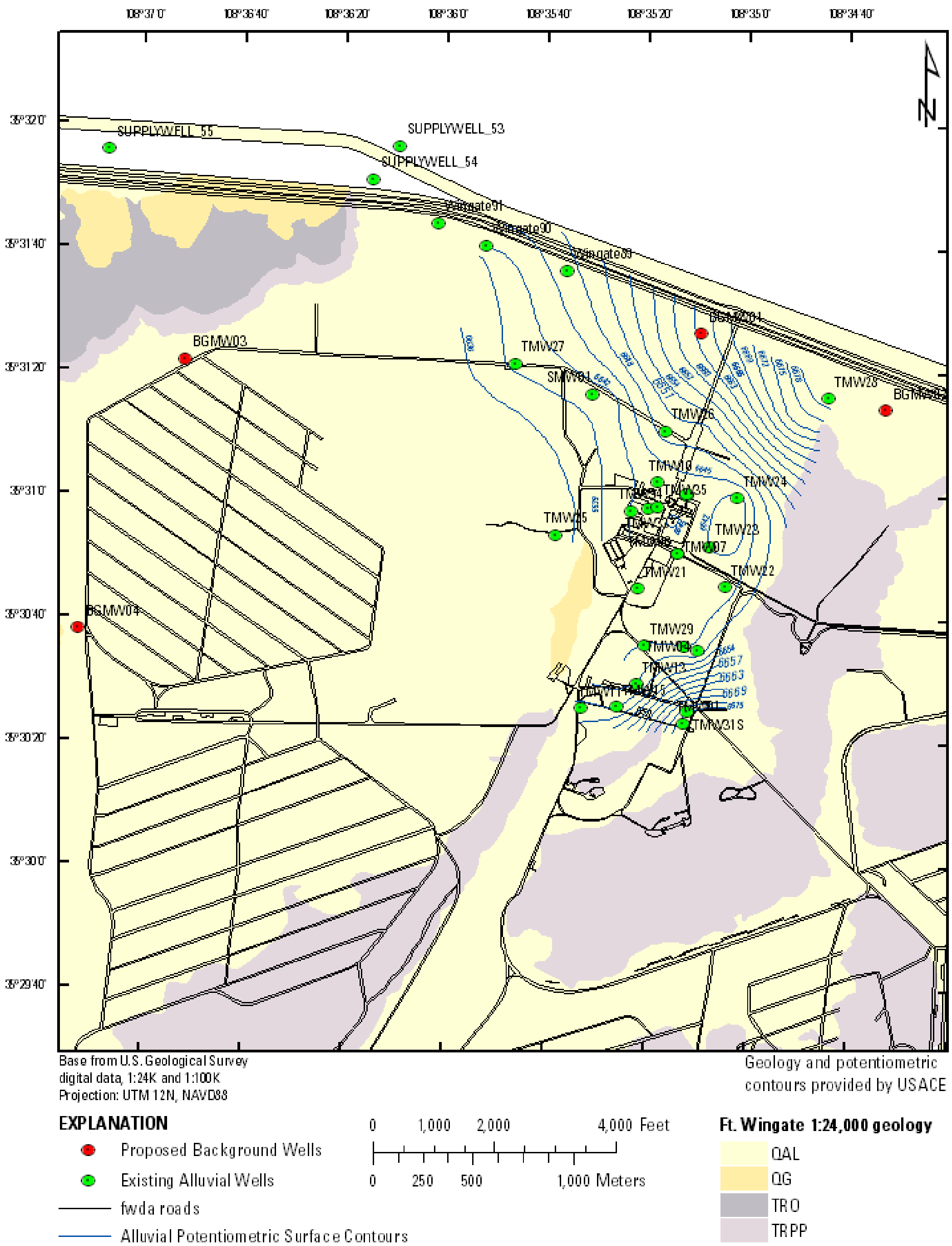


Figure 5: Background Well Locations [Potentiometric contours constructed by USACE (USACE, 2010)]

3.3 RDX PLUME MONITORING WELLS

Three explosives' plume monitoring wells will be installed in Phase 2 (summer of 2012) of this project. Concentrations of RDX above post clean-up standards, suspected of originating at the former trinitrotoluene (TNT) leaching beds have been identified in the alluvial groundwater (Figure 6). The concentration of RDX throughout the plume is an estimate based on the interpolation of chemical data obtained from two monitoring wells, TMW03 near the source and TMW23 approximately 0.3 miles to the north. Historically, the RDX plume has been bound by concentrations far below clean-up standards in monitoring wells TMW04, TMW06, TMW07, TMW21, TMW22, and TMW29.

Monitoring wells TMW43 and TMW44 will be installed between TMW03 and TMW23 in order to refine the concentration gradient in the center of the plume and allow for contaminant mass discharge estimates. These monitoring wells will also aid in defining the concentration gradient of nitrate in the alluvium, which comingles with the RDX plume. Monitoring well TMW45 will be installed north of TMW23 in order to bound the northern extent of the plume (Figure 6).

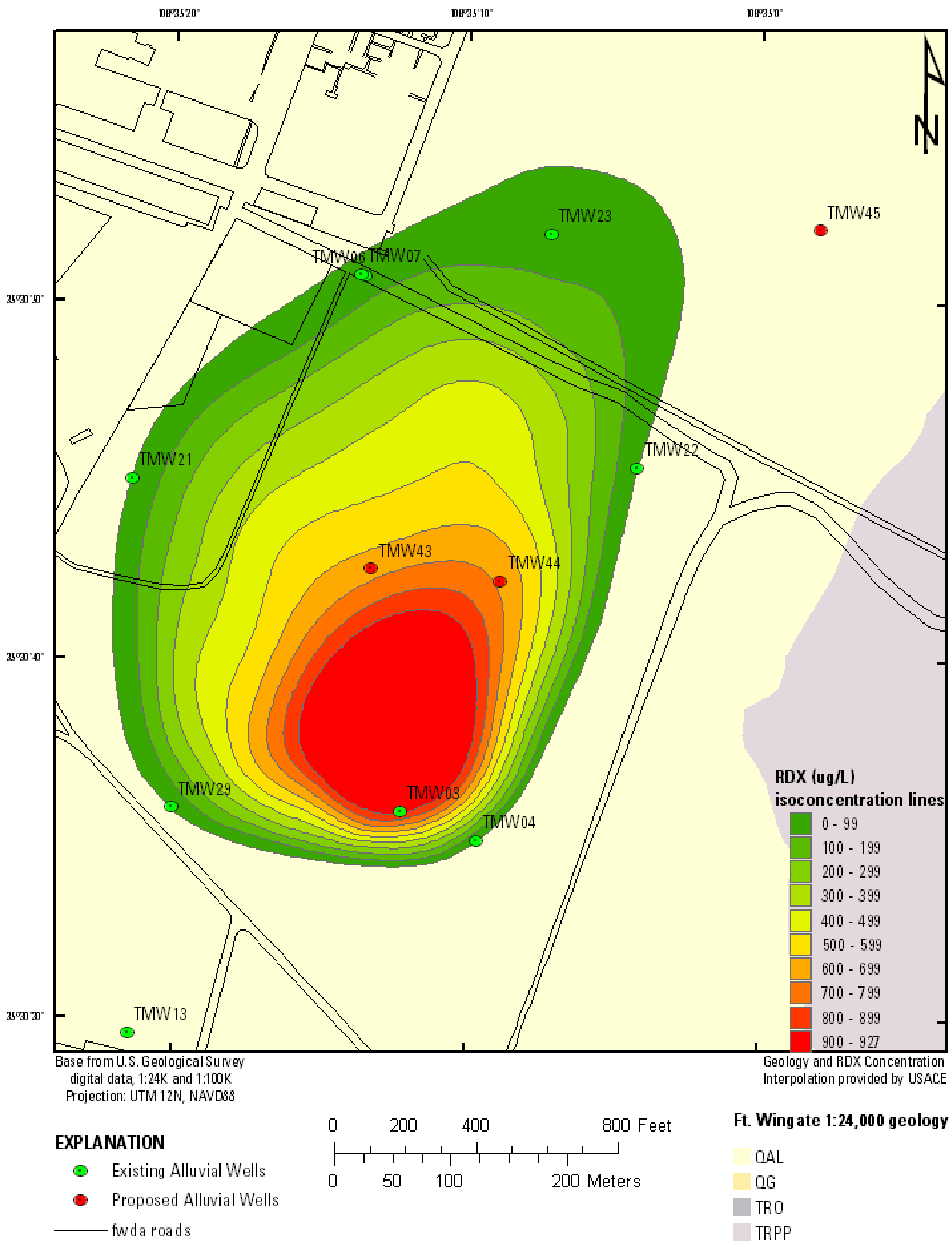


Figure 6: RDX Monitoring Well Locations [Plumes constructed by USACE (USACE, 2010)]

3.4 NITRATE PLUME MONITORING WELLS

Two nitrate plume monitoring wells will be installed in Phase 2 (summer of 2012) of this project. Nitrate concentrations above clean-up standard have been identified in the alluvial groundwater underlying the administration and workshop areas. The nitrate plume comingles with both the RDX plume discussed above and the perchlorate plume discussed below. Because nitrate can exist naturally in groundwater, the Environmental Protection Agency's (EPA) Maximum Contaminant Level (MCL) of 10 mg/L for nitrate is used to delineate the extent of the plume. The nitrate plume is bound to the west by nitrate concentrations of less than 10 mg/L at TMW13, TMW15, and TMW25 and to the east where the alluvium is believed to be unsaturated. The nitrate plume is also bound to the north by nitrate concentrations of less than 10 mg/L detected in groundwater samples collected from monitoring wells TMW08, TMW10, and TMW24. However, the nitrate plume boundaries in the east, northeast corner, and northwest corner are not completely delineated.

Monitoring wells TMW46 and TMW47 will be installed to provide chemical data that will delineate the northwest and eastern boundaries of the alluvial nitrate plume. Additionally, because the nitrate alluvial plume comingles with the RDX plume and alluvial perchlorate plume, monitoring wells installed to characterize these plumes will also be used to further characterize the alluvial nitrate plume (Figure 7).

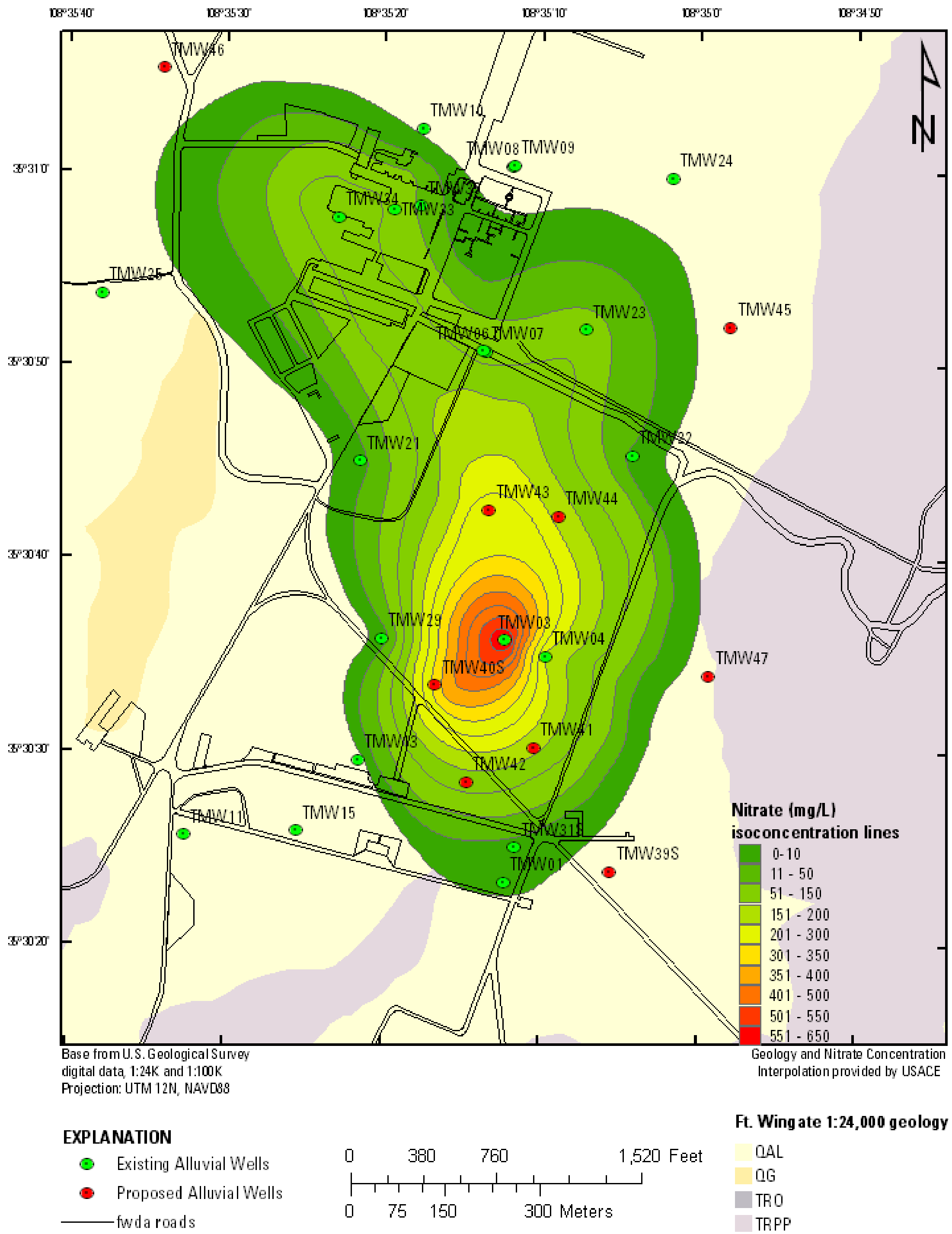
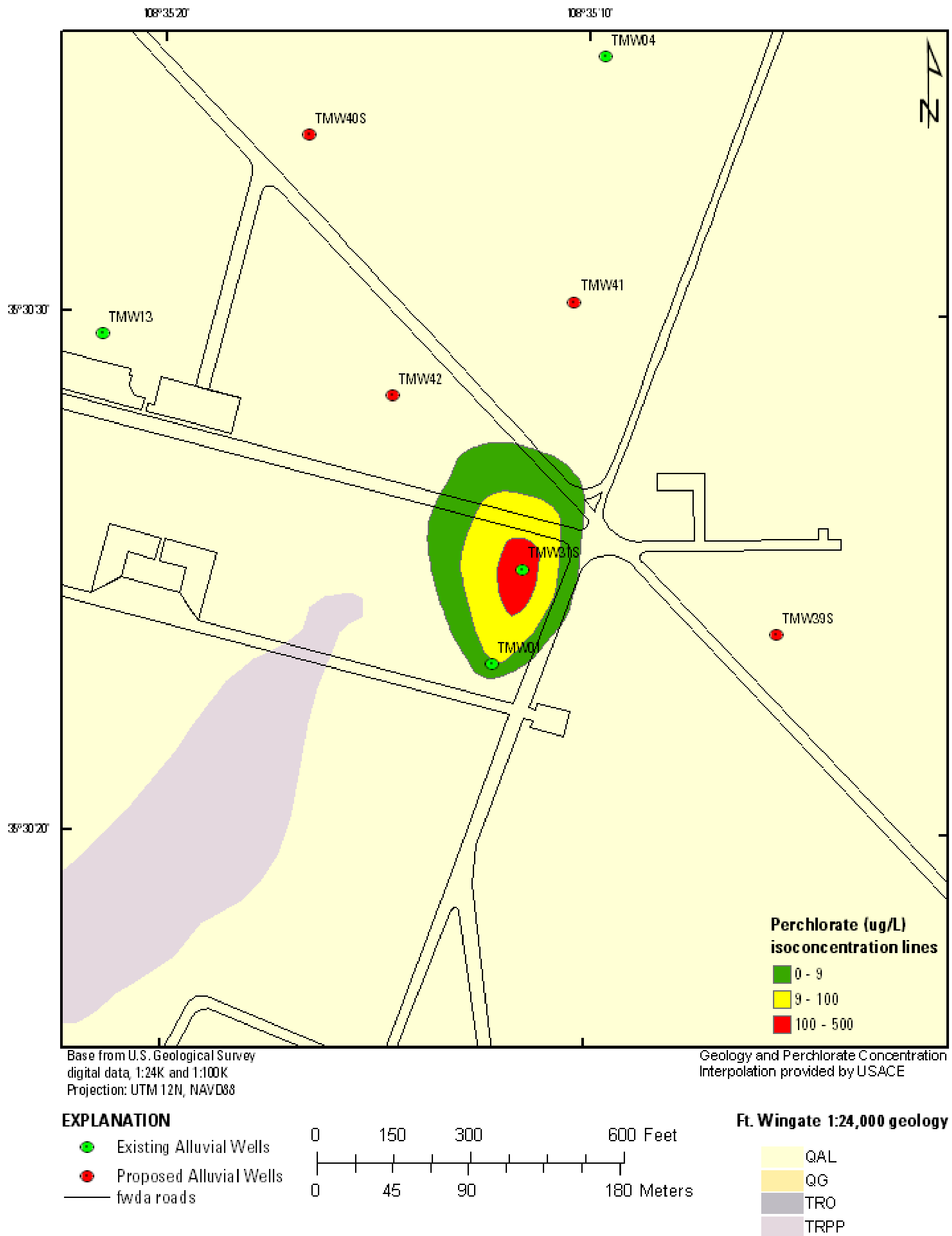


Figure 7: Nitrate Monitoring Well Locations [Plumes constructed by USACE (USACE, 2010)]

3.5 PERCHLORATE PLUME MONITORING WELLS

Three to four alluvial monitoring wells and three bedrock monitoring wells will be installed to further delineate the perchlorate plume in Phase 1 (summer of 2011) of this project. Perchlorate concentrations exceeding post clean-up standards have been identified in both the alluvial and bedrock groundwater between the former TNT leaching beds and the former building 528. The extent of the alluvial perchlorate plume is estimated based on chemical results of samples collected from monitoring wells TMW01 and TMW31S. The alluvial perchlorate has only been bound much further to the north and northwest. The bedrock perchlorate plume is estimated based on results of groundwater samples that have been collected from TMW30, TMW31D, and TMW32. The plume is not completely delineated to the northwest.

Alluvial monitoring wells TMW39S, TMW41, and TMW42 will be installed to aid in delineating the lateral extent of the perchlorate plume (Figure 8). Because the alluvial perchlorate plume comingles with the nitrate plume, these perchlorate monitoring wells will also help define the alluvial nitrate plume. If the perchlorate concentrations found in monitoring wells TMW41 and TMW42 indicate that additional data is required to accurately define the boundaries of the plume, an additional well will be installed (TMW40S). If TMW40S is required, it will be part of a dual borehole collocated with TMW40D, which will be drilled in to bedrock to monitor the bedrock perchlorate plume. TMW40S may be required to determine the extent of perchlorate in the alluvium in the northwestern direction. Three bedrock monitoring wells will also be installed to define the lateral extent of the bedrock perchlorate plume, TMW38, TMW39D, and TMW40D (Figure 9). Chemical data obtained from TMW38 and TMW40D will be used to define the northwest and southwest extends of the plume. Chemical data collected from TMW39D will be used to evaluate the northeast extent of the plume. Hydraulic gradient in the bedrock is expected to slope to the west, based on historical groundwater elevations (Figure 9).



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2 **Figure 8: Perchlorate Alluvial Monitoring Wells [Plumes constructed by USACE (USACE, 2010)]**

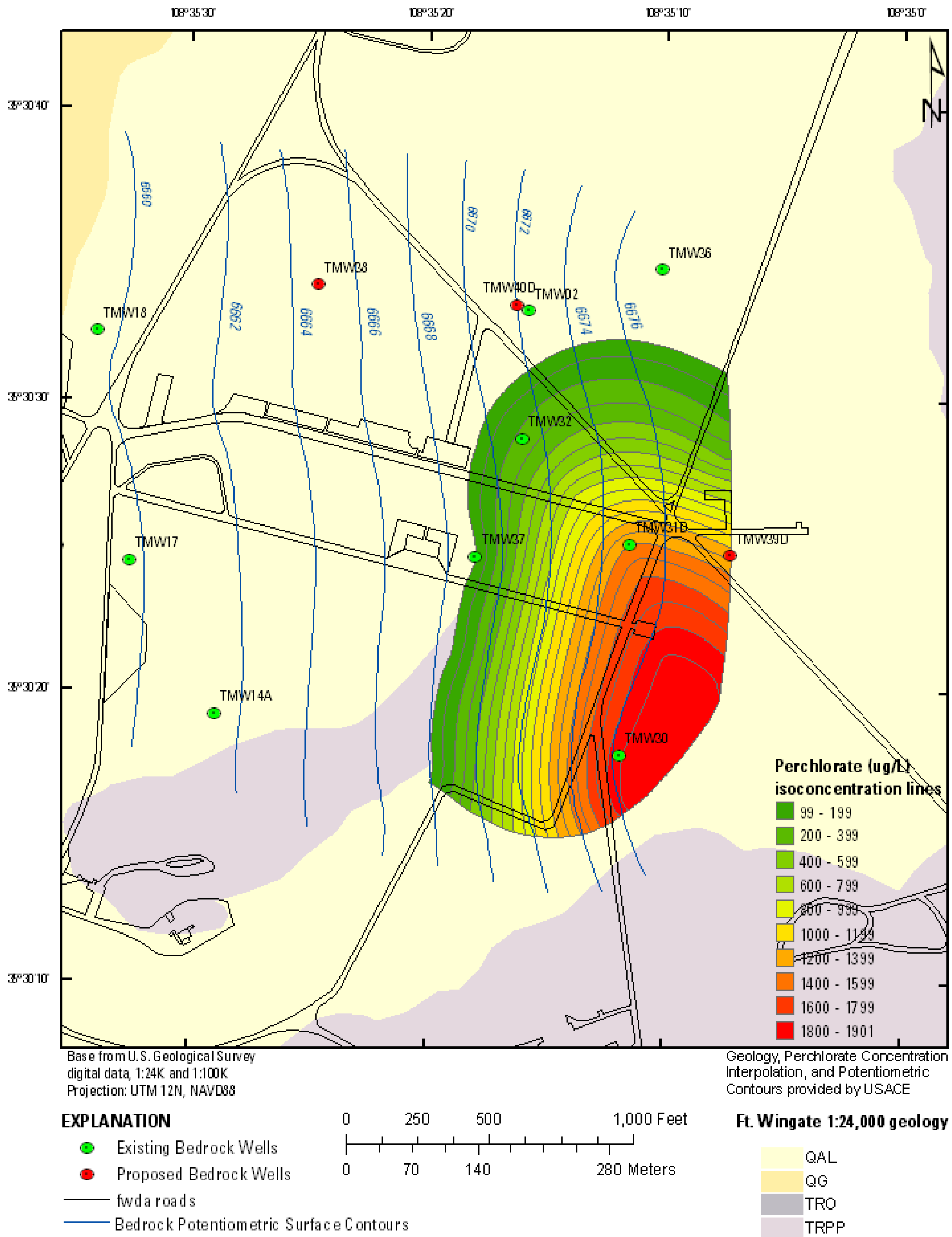

Figure 9: Perchlorate Bedrock Monitoring Wells [Plumes and potentiometric contours constructed by USACE (USACE, 2010)]

4.0 WELL INSTALLATION

Well installation will be conducted in two phases beginning in the summer of 2011. Projected project completion is August 2012. In addition to NMAC 19.27.4, monitoring well design and installation will be constructed in accordance with NMED and EPA guidelines.

4.1 DRILLING LOGS AND DOCUMENTATION

Project logbooks will be used to document all activities associated with project including site conditions, attendant personnel and equipment, changes to protocols made in the field, and task lengths.

The site geologist will record detailed lithologic information during the drilling and installation of all the monitoring wells. The information to be recorded is described below.

- Depths/heights will be recorded in feet and/or fractions of feet;
- Type of sample that the description is determined from;
- Soil classifications in accordance with the Unified Soil Classification System (USCS) will be field determined and recorded;
- Soil samples will be fully described on the drilling log;
- Descriptions of rock fragments will be included;
- The length of sample recovered for each sampled interval will be recorded; and
- The estimated interval for each sample will be recorded.

The site geologist or head driller will record the drilling progress and construction details and materials used during the completion of the well. A standard well construction log will be used to document construction specifications and materials. Information recorded on well construction diagram will include:

- Drilling method (air, mud, auger);
- Drilling medium (if mud, type and weight of mud);
- Borehole diameter, type of casing and screen used, and the depth and length of the screened interval; and
- Amount, type and depth of sand pack, seal and grout.

The drilling logs will be provided to the USACE site geologist at the completion of the project.

4.2 MONITORING WELL INSTALLATION

The New Mexico Water Science Center will obtain a monitoring well installation permit from the OSE prior to drilling and will provide a copy of the permit to the USACE site geologist.

All drilling equipment and hand tools to be used for drilling and completion of wells will be decontaminated prior to arrival at each site and as necessary. Precautions will be taken to minimize accumulation of dust and other potential contaminants of drilling tools and well materials during transport.

Boreholes for the installation of monitoring wells in the alluvium will be drilled using Hollow Stem Auger (HSA) drilling methods. Alluvial monitoring wells will be drilled approximately 10 ft below the water table. Alluvial monitoring well screens will be will be 20 ft long and the tops of the screens will be placed 5 to 10 ft above the zone of saturation if practical.

Wells installed in the bedrock will be installed using Air-Rotary methods. Bedrock monitoring wells will be drilled through the saturated thickness of the target bedrock unit. Screens for bedrock monitoring wells will be placed through the entire thickness of the saturated interval. Dry holes will be backfilled with bentonite.

4.2.1 ALLUVIAL MONITORING WELL CONSTRUCTION SPECIFICS

- All lithologic descriptions will be taken from cuttings brought to the surface by the auger flights.
- Casing and screen will be threaded Schedule 40 or 80 PVC, 2 or 2 ½ -inch nominal inside diameter. The well screen will be factory slotted, with a slot width of 0.010-inch.
- Shallow monitoring well screen lengths are estimated to be 20 ft and placed across the water table (the exception to this is the two sentinel wells which will be screened at the same depth as the water supply well NTUA 16T602).
- The filter sand used for the filter pack will be compatible with both the well screen size and the aquifer materials. The filter pack will be brought to a level of at least 2 ft above the top of the screen.
- A 5 ft bentonite pellet seal will be installed on top of the filter pack followed by a 20% bentonite grout, which will be backfilled to the surface.
- After grout shrinks (1-2 days), the well annulus will be backfilled to with bentonite chip to 10 ft below land surface and hydrated. The remaining 10 ft of annulus will be filled with portland cement.
- All wells will be fitted with a lockable, vented cap.

4.2.2 BEDROCK MONITORING WELL CONSTRUCTION SPECIFICS

- Bedrock will be cored and described on-site. The cores will be released to the USACE following completion of drilling.
- Monitoring wells proposed for bedrock will be drilled through the saturated thickness of the sandstone hydrogeologic unit, to the top of an underlying claystone unit.
- The screens for bedrock monitoring wells will be set through the entire saturated intervals of the sandstone, which is estimated between 15 to 25 ft in thickness.
- The filter sand used for the filter pack will be compatible with both the well screen size and the aquifer materials. The filter pack will be brought to a level of at least 2 ft above the top of screen.
- A 5 ft bentonite pellet seal will be installed on top of the filter pack followed by a 20% bentonite grout, which will be backfilled to the surface.
- After grout shrinks (1-2 days), the well annulus will be backfilled to with bentonite chip to 10 ft below land surface and hydrated. The remaining 10 ft of annulus will be filled with portland cement.
- All wells will be fitted with a lockable, vented cap.

Wells will be finished with a 4x4 concrete pad, secure well protective cover, brass survey marker, and four bollards. A general monitoring well diagram is shown in Figure 10.

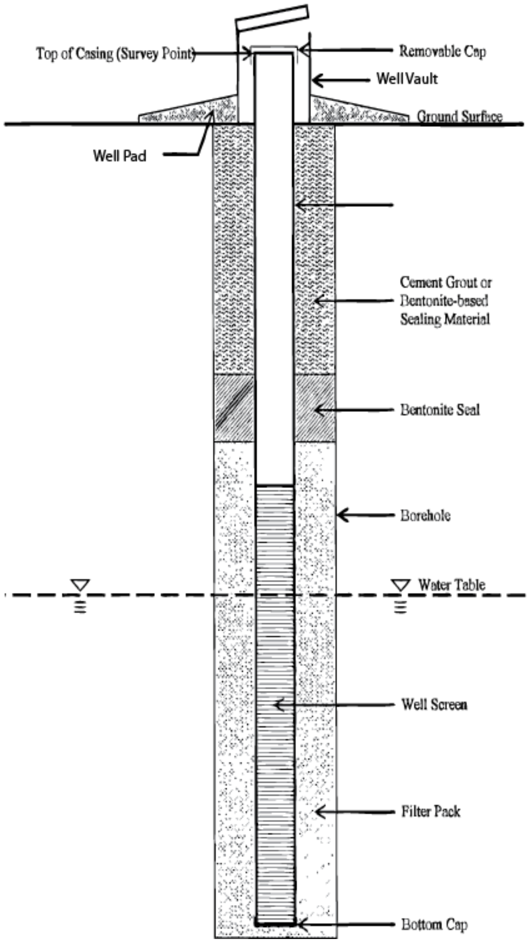

Figure 10: Monitoring Well Diagram

4.3 WELL DEVELOPMENT

Once the monitoring wells have been constructed, preliminary well development will be initiated by using air or surge block to remove sediment and stabilize the filter pack.

Well development of newly-installed monitoring wells will begin no sooner than 24 hours after placement of the grout.

Well development will proceed until the following criteria are met:

- The well water is clear to the unaided eye;
- The sediment thickness remaining in the well is less than 1% of the screen length; and
- The required 5 saturated well volumes plus 5 times any water used in well completion are removed.

It may be possible that the above criteria are unattainable; the USACE site geologist will be consulted to determine whether the criteria are attainable.

During development, the site geologist or designated field technician will maintain a Well Development Log. Information to be recorded:

- Well designation
- Date of well installation
- Date of well development
- Field measurement of pH, specific conductance, temperature, and turbidity before, twice during, and after development
- Depth from top of well casing to bottom of well
- Screen length
- Depth from top of well casing to top of sediment inside well, before and after development
- Physical characteristics of removed water, including changes in clarity, color, particulates, and odor
- Type and size/capacity of pump and/or bailer used
- Height of well casing above ground surface
- Typical pumping rate
- Estimated recharge rate

Cuttings and fluids generated during drilling and development of monitoring wells will be containerized and staged at a central location. Cuttings and fluids will be managed as Investigation Derived Waste (IDW) as described in section 4.4.

4.4 INVESTIGATION DERIVED WASTE

Containers (e.g. 55 gallon drums, roll-offs or totes) conforming to United Nations Performance-Oriented Packaging standards and Department of Transportation (DOT) specifications in 49 Code of Federal Regulations (CFR) 178 will be stored at the site of generation or a central location until a disposition is reached from the analytical results. A label reading “Caution, This Drum/Container May Contain Hazardous Material - Pending Analysis” or similar will be affixed to each drum/container.

Each container will be labeled with a unique ten-character identifier: the first two characters are “FW,” the second two will be “GW” for groundwater or “WC” for well cuttings, the next four are the julian date on which filling commenced, and the last two are the consecutive number of the container among all being filled on a given day.

Example Identifier:
FWGW**268**6**01** is:
FW Fort Wingate Depot Activity
GW Ground water purge and decontamination water
268 25 September
6 2006
01 Container 01

The label shall also indicate the contents (e.g., drill cutting, decontamination fluids, etc.), the source (e.g., monitor well number), and the date on which filling is completed (90-day start date).

Representative samples will be collected from each container and composited on the basis of matrix and method of generation to characterize the IDW for disposal as hazardous, special, or non-hazardous waste. Characterization results for these media shall serve to classify associated sampling equipment and personal protective equipment (PPE) for disposal, unless this PPE and equipment was decontaminated prior to disposal, in which case it will be handled as general refuse. Samples will be collected within 20 days of the date on which the drum is filled, and analytical results will be provided within 25 days of sampling. IDW samples will be analyzed for the appropriate RCRA parameters (e.g., ignitability, corrosivity, RCRA VOCs, SVOCs, pesticides, and metals).

IDW will be classified as hazardous waste if the material exhibits the characteristics of ignitibility, corrosivity, reactivity, or toxicity as listed by the USEPA in 40 CFR 261.20-24. IDW will be classified as non-hazardous waste if potential contaminants are not detected or are detected at concentrations less than applicable regulatory limits.

All IDW classified as hazardous as described above will be manifested and transported off site within 90 days of the container being filled. IDW classified as hazardous waste will be disposed of off-site at a RCRA Subtitle C permitted treatment, storage, and disposal (TSD) facility. Prior to transport, containers of shall be labeled according to DOT regulations in 49 CFR 172. This labeling shall be displayed in accordance with DOT requirements in 49 CFR 172.304. Manifests will be prepared according to USEPA requirements in 40 CFR 262.20, and acquisition, copies, and use of the manifest will be in accordance with USEPA requirements in 40 CFR 262.21-23. Ft. Wingate qualified staff will sign the manifest as the generator. The transporter, who shall be fully licensed and insured to transport hazardous waste, will then sign the manifest and a copy will be provided both the Ft. Wingate records and USACE Technical Manager.

Concurrent with the manifest, a Land Disposal Restriction (LDR) shall be prepared in accordance with USEPA requirements in 40 CFR 268.7 in the event that the generated waste is determined to be hazardous. A signed LDR shall accompany each shipment of hazardous waste and serve as notification to the receiving TSD facility of any requirements for treatment prior to land disposal.

Used, non-decontaminated sampling equipment/PPE will be placed in polyethylene trash bags and be managed as IDW. General refuse and decontaminated sampling equipment/PPE may be disposed of in FWDA trash containers, or transported off-site for disposal as municipal waste if large quantities of material are generated. Small quantities of well or decontamination water may be placed in the on-site lined evaporation tank. Large quantities of liquid IDW classified as nonhazardous waste shall be transported off-site to a facility approved for disposal of such material.

5.0 GROUNDWATER SAMPLING

5.1 WATER LEVEL MEASUREMENTS

All water level measurements in newly-installed monitoring wells will be obtained with an electric water level tape (e-tape). Measurements will be made relative to a notch or other permanent mark that serves as a consistent measurement reference point. These measurements will be recorded to ± 0.01 feet.

5.2 MONITORING WELL SAMPLING

All new monitoring wells will be added to the facility-wide groundwater monitoring program and included in the following sampling event. The two new sentinel monitoring wells (MW23 and MW24) will be sampled no sooner than 14 days after completion of the well-development process. Wells will be sampled for total and dissolved metals (EPA 6010B/7471A), anions (EPA 300.0), nitrate (EPA 9056A), volatile organic carbon (EPA 8260B), diesel range organics (EPA 8015B), gasoline range organics (EPA 8015B), dioxins/furans (EPA 8280A), explosives (EPA 8330B), and perchlorate (EPA 6860).

5.2.1 MONITORING WELL PURGE AND SAMPLING EQUIPMENT

Pre-sampling purging and sampling will be completed using a centrifugal pump, bladder pump, or bailer methodologies as determined by aquifer recharge rates and total well depth.

5.2.2 PURGE WELL

Removal of a quantity of water equal to three times the calculated volume of standing water in the well (including the saturated annulus) will be completed wherever possible. If the recovery rate is rapid, the well will be allowed to recover to its original volume prior to sampling. If recovery is very slow, samples may be obtained as soon as sufficient water is available after a minimum of one well volume has been removed. Sampling logs will identify the type of equipment used for purging and sampling.

5.2.3 MONITOR FIELD PARAMETERS

During well purging, indicator field parameters (turbidity, temperature, specific conductance, pH, and dissolved oxygen (DO)) will be monitored and recorded in the project logbook or field form. Purging is considered complete and sampling will begin when the indicator field parameters have stabilized. Stabilization has occurred when three consecutive readings, are within the following limits:

- turbidity (10% for values greater than 1 NTU)
- DO (10%)
- specific conductance (3%)
- temperature (3%)
- pH (± 0.1 unit)

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. If after three well volumes are evacuated during purging, indicator field parameters have not stabilized, purging will be discontinued, samples will be collected, and a full explanation of attempts to achieve stabilization will be provided.

5.2.4 COLLECT WATER SAMPLES

Water samples for laboratory analyses will be collected using a dedicated bailer or pump or a decontaminated portable pump. A constituent sampling order and sample container will be determined prior to initiating field activities. After a sample container is filled, the container will be labeled with the date and time and immediately placed into a cooler with ice. Sample management will be conducted as discussed in Section 5.3.4.

5.2.5 POST SAMPLING ACTIVITIES

After collection of the samples, the sampling equipment will be removed from the well. Disposable materials will be properly discarded. The total well depth (to ± 0.01 feet) will be measured and recorded, and the well will be secured.

5.3 FIELD AND SHIPPING DOCUMENTATION

5.3.1 FIELD DOCUMENTATION

Sample control and tracking information will be recorded in bound field logbooks and will include the following information: sample number and location, date and time, sampling equipment, sampler's name, method of sampling, ambient weather conditions, and miscellaneous observations. In addition, field instrument calibrations will be recorded in a designated portion of the logbook at the time of the calibration. Adverse trends in instrument calibration behavior will be corrected.

5.3.2 SAMPLE ID

Sample identification (ID) will be consistent with USACE requirements. Sample ID = WELL ID MMYYYY.

5.3.3 CHAIN-OF-CUSTODY

Chain-of-custody forms will be completed and will accompany each sample at all times. Data on the forms will include the sample ID, tracking number, depth interval, date sampled, time sampled, project name, project number, and signatures of those in possession of the sample. Forms will accompany those samples shipped to the designated laboratory so that sample possession information can be maintained. The field team will retain a separate copy of the chain-of-custody reports at the field office.

5.3.4 PACKAGING AND SHIPPING

All samples will be shipped daily by overnight airfreight to the Test America laboratory, in Arvada, Colorado. Unless otherwise indicated, samples will be treated as environmental samples, shipped in heavy-duty coolers, packed in materials to prevent breakage, and preserved with ice in sealed plastic bags. Each shipment will include the appropriate field QC samples (i.e., trip blanks, duplicates, field blanks, and rinsate blanks). Corresponding chain-of-custody forms will be placed in waterproof bags and placed inside of the coolers lids. Each cooler shipped from the laboratory containing aqueous sample bottles for VOC analyses will contain a trip blank. The trip blank will stay with the cooler until the cooler is returned to the analytical laboratory.

5.4 DECONTAMINATION PROCEDURES

Decontamination of non-disposable sampling equipment (e.g., water level meter) will be performed to ensure chemical analyses reflect actual concentrations at sampling locations by maintaining the quality of samples and preventing cross-contamination. Sampling and field equipment cleaned in accordance with the following sections will meet the minimum requirements for definitive-level data collection. General specifications for equipment and personnel decontamination are discussed in the following paragraphs.

5.4.1 SPECIFICATIONS FOR CLEANING MATERIALS

Specifications for standard cleaning materials referred to in this section are as follows:

- Soap will be a standard brand of phosphate-free laboratory detergent. Use of other detergent will be documented in the field logbooks and investigative reports. Soap will be obtained from a laboratory supply distributor.
- Tap water will be obtained from the on-site water supply system (if operable) or from potable water purchased locally.
- Analyte free water (deionized water) is water that has been treated by passing through a standard deionizing resin column.

5.4.2 HANDLING AND CONTAINERS FOR CLEANING SOLUTIONS

Improperly handled cleaning solutions may easily become contaminated. Storage and application containers must be constructed of the proper materials to ensure their integrity. Following are acceptable materials used for containing the specified cleaning solutions:

- Soap will be kept in clean plastic, metal, or glass containers until used. It will be poured directly from the container during use.
- Solvent will be stored in the unopened original containers until used.
- Tap water will be kept in clean tanks, hand-held sprayers, squeeze bottles, or applied directly from a hose.
- Constituent free water will be stored in clean glass, stainless steel, or plastic containers that can be closed until just prior to use. It may be applied from plastic squeeze bottles.

5.4.3 SAFETY PROCEDURES FOR FIELD CLEANING OPERATIONS

Some of the materials used to implement the cleaning procedures outlined in this section can be harmful if used improperly. Caution should be exercised by all field personnel and all applicable safety procedures should be followed. At a minimum, the following precautions will be observed in the field during decontamination operations:

- Safety glasses with splash shields or goggles, and latex or nitrile gloves will be worn during all cleaning operations.
- No eating, smoking, drinking, chewing, or any hand to mouth contact shall be permitted during cleaning operations.
- All decontamination fluids will be properly containerized and managed as described in Section 5.5.

5.4.4 HANDLING OF CLEANED EQUIPMENT

After field cleaning, equipment will be handled only by personnel wearing clean gloves to prevent re-contamination. The equipment will be moved away from the cleaning area to prevent re-contamination. If the equipment is not to be immediately re-used it will be covered with plastic sheeting or wrapped in aluminum foil to prevent re-contamination. The area where the equipment is stored prior to re-use must be free of contaminants.

5.5 INVESTIGATION-DERIVED WASTE CHARACTERIZATION AND DISPOSAL

Three types of Investigation Derived Waste (IDW) may be generated during the sampling of ground water: monitoring well purge water, decontamination fluids, and disposable sampling equipment and personal protective equipment (PPE). It is anticipated that the quantity of waste generated during groundwater sampling will be small and therefore may be placed in the on-site evaporation tank. If quantities of well purge water and decontamination fluids are larger than can reasonably be handled by the evaporation tank or there is sampling equipment and/or PPE that cannot be decontaminated, than that waste will be handled as IDW under the protocols set forth in Section 4.4.

6.0 WELL ABANDONMENT

Ten groundwater monitoring wells, in which the water table has fallen below the screened interval will be plugged and abandoned. These monitoring wells will be plugged and abandoned in accordance with OSE regulations to ensure that they do not serve as conduits for the migration of contaminants from the ground surface to the aquifer in which they are screened.

6.1 MONITORING WELLS TO BE ABANDONED

The monitoring wells selected for abandonment, their locations (northing and easting), their casing diameters, and their total depths are shown in the Table 1 and their locations shown in Figure 11.

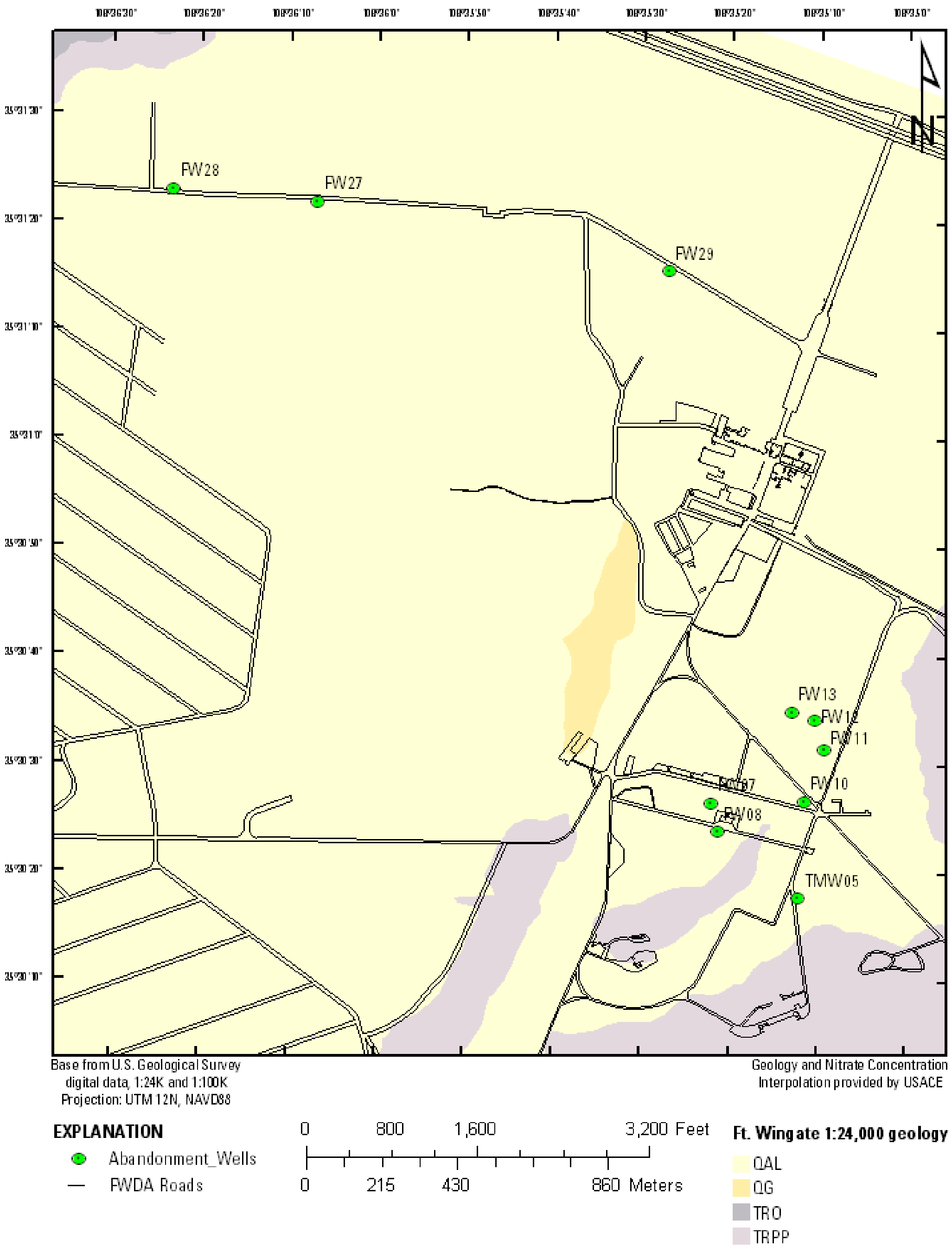

Figure 11: Monitoring Wells to be Abandoned

Table 1: Monitoring wells to be abandoned

WELL ID	NORTHING (New Mexico State Plane-West, feet)	EASTING (New Mexico State Plane-West, feet)	CASING DIAMETER (INCHES)	BORING / WELL DEPTH (FEET)
TMW05	1639949.83	2498884.78	2.0	37.40
FW07	1640839.18	2498075.06	4.0	30.50
FW08	1640572.50	2498132.47	4.0	51.00
FW10	1640848.95	2498936.89	4.0	51.50
FW11	1641334.02	2499124.16	4.0	28.00
FW12	1641609.82	2499038.13	4.0	29.00
FW13	1641688.39	2498830.01	4.0	30.50
FW27	1646461.42	2494395.93	4.0	32.00
FW28	1646584.14	2493050.57	4.0	33.00
FW29	1645804.02	2497681.98	4.0	32.00

The wells selected for abandonment were chosen primarily for their historical lack of groundwater to sample as intended. Groundwater data gaps for the purpose of developing potentiometric surface maps and delineating groundwater contaminant plumes resulting from the lack of groundwater have been either replaced with new wells or have been filled by interpolation.

Up to ten monitoring wells associated with the Open Burn/Open Detonation (OB/OD) Area in Parcel 3 will be abandoned in future efforts. These monitoring wells are either dry, buried, or too close to proposed ordnance clearing and digging operations to remain in place. Monitoring wells CMW06, CMW16, and CMW21 are buried beneath arroyo sediments and not useable, and FW38 and KWM13 are dry and not usable. Monitoring wells within the boundaries OB/OD Area will be damaged during ordnance clearing and digging operation. Therefore, abandonment of these wells will occur as clearing and digging operations progress. Parcel 3 work plans will be submitted to NMED at a future date describing the abandonment process for monitoring well abandonments in Parcel 3.

6.2 METHOD OF ABANDONMENT

Monitoring wells will be plugged and abandoned in accordance with OSE regulations in NMAC 19.27.4. USACE will submit a Well Abandonment Plan in accordance with New Mexico regulations to the OSE for review and approval. Once approval is obtained, USACE will provide NMED a copy of the Well Abandonment Plan.

In general, all monitoring wells will be abandoned by placing a cement/bentonite cement slurry in the casing of each monitoring well with a tremie pipe. The borehole will be filled with cement/bentonite starting at the bottom and filling upward until the casing is completely sealed with the slurry. All well casings will be cut off below ground surface, and the well pads will be removed.

Any fluid or material removed from the abandonment borehole shall be segregated and handled as IDW according to section 4.4.

7.0 PROJECT MANAGEMENT

7.1 QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

7.1.1 FIELD GROUNDWATER DATA QUALITY ASSURANCE

Monitoring field parameters will take place on instruments calibrated on a daily basis. Several types of field quality control samples may be submitted to the analytical laboratory to assess the quality of the data resulting from the groundwater sampling. These samples may include field ambient blanks, equipment rinse blanks, matrix spike (MS) and MS duplicate samples, and field sample duplicates.

7.1.2 DOCUMENTATION QUALITY ASSURANCE

Permanently bound logbooks will provide a daily handwritten record of all field activities at the investigation site. Logbooks will be ruled, or ruled and gridded, with sequentially numbered pages. All entries into field logbooks will be made with indelible ink. Separate logbooks shall be used for each sampling and field team. If entries in the logbooks need to be corrected or changed, corrections will be made by crossing out mistakes with a single line, writing the corrections, and initialing and dating the entry.

Photographs will be taken to photo-document all field activities using high-resolution digital cameras. Photographs taken during field activities will be sequentially numbered and documented in the field logbook with location, direction, and description of the activity.

7.2 HEALTH AND SAFETY PLAN

Employees are required to be familiar with The Site Safety and Health Plan (SSHP) for Ft. Wingate and appropriate USGS safety policies. Copies of the SSHP and the USGS Safety and Health Field Handbook as well as other technical references are available both on-site and at the district office.

7.3 LOG AND DATA DISPOSITION REQUIREMENTS

All drill logs referenced in Section 4.1 will be completed for each well and given the USACE site geologist upon project completion.

Copies of waste manifests and analytical results will be given to Ft. Wingate personnel for the generator records.

Field sampling log sheets and laboratory analytical reports from the groundwater sampling will be sent to the USACE site geologist

7.4 SCHEDULE

The Fort Wingate Monitoring Well Installation and Abandonment Plan task schedule is shown in Table 2. This schedule is preliminary and dependent on when the Work Plan is approved.

Table 2: Project Task Schedule

TASK	Approximate Date
Submit Work Plan to NMED	**April 2011**
Submit monitoring well permits and abandonment plans to OSE	**April 2011**
Begin Phase 1 drilling and abandonment (Sentinel and Perchlorate)	**June 2011**
Begin Phase 2 drilling (Background, RDX, and Nitrate)	**June 2012**

All work described in this work plan is scheduled to be completed in October 2012.

8.0 REFERENCES

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