WELLHEAD PROTECTION IN GRENADA, MISSISSIPPI

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INTRODUCTION

The Wellhead Protection Program (WHPP) was established under the 1986 amendments (Section 1428) of the Federal Safe Drinking Water Act (SDWA). This program represents a proactive approach to groundwater protection that is specifically designed to prevent or minimize contamination of groundwater sources used for public water supply (PWS). One of the key elements of the EPA program is the requirement that wellhead protection areas be delineated and protected around PWS wells. These areas are defined as "the surface and subsurface area surrounding a public water supply system, through which contaminants are reasonable likely to move toward and reach each water well or wellhead."

In Mississippi, principal state governmental responsibility for groundwater protection efforts lies with the Mississippi Department of Environmental Quality - Office of Pollution Control (MDEQ-OPC). This agency developed Mississippi's State WHPP which received final approval from the EPA in September of 1993.

As a first step toward implementation of this program, the City of Grenada was selected as the state's initial WHP demonstration project. This selection was based on the relative susceptibility of the City's shallow PWS wells to surficial contamination and the size of the City. Available funding from the EPA allowed the MDEQ to contract a consultant, Waggoner Engineering, Inc. (WEI), to assist in the development of the WHP project in Grenada.

WHP efforts in the City of Grenada followed the basic steps outlined in the State WHPP:

1. Initial meetings were held between the MDEQ, WEI, and City officials to discuss the WHPP. A local WHP Advisory Committee was formed to complement local wellhead protection efforts.

2. A hydrogeologic assessment of the area surrounding the City's PWS wells was performed by WEI with assistance from the MDEQ.

3. WHPAs were delineated for the PWS wells by WEI with assistance from the MDEQ.

4. An inventory to identify all potential contaminant sources (PCSs) located within the delineated WHPAs was performed by the MDEQ. A list of PCSs and maps showing their locations was delivered to WEI.

5. A WHP Management Plan document was prepared to address the management of all PCSs identified within the WHPAs. WEI prepared the plan with assistance from the WHP Advisory Committee and the MDEQ. The plan includes the identification of various best management practices, land use provisions, and a public awareness campaign.

6. A public hearing regarding the preliminary management plan will be held in the City to receive local input and comment.

7. A final WHPA Management Plan document will be prepared by WEI and submitted to the City and the MDEQ for approval.

Significant time and effort were expended on this project in anticipation that it would yield a blueprint for the development of other local WHP plans in cities throughout Mississippi.

LOCAL CONSIDERATIONS

Physiography and Drainage

The City of Grenada is centrally located in Grenada County in north-central Mississippi. It is situated in a flood plain near the confluence of the Yalobusha River, positioned along the northern edge of the City, and Batupan Bogue Creek which flows along the eastern edge of the City. Also providing drainage to the residential and commercial areas of the City are Perry Creek, Brown Creek, and Tributary 1 of the Yalobusha River. Due to flooding events which frequented the City and the Yazoo River Basin in the past, the U.S. Army Corps of Engineers

constructed a large flood-control dam and reservoir, Grenada Lake, approximately 3 miles northeast of Grenada in the 1950s. Even with the presence of the reservoir, stormwater drainage remains a problem in the City.

City of Grenada Public Water Supply (PWS) System

Wells/Wellfields. The City of Grenada operates its own public water supply (PWS) and distribution system to supply its 12,848 residents and the industries of Grenada plus adjacent communities through 4879 service connections. The City operates eight municipal water wells; five are located in a wellfield near the center of the City; two are positioned in another wellfield along the northern edge of the City; and a single well furnishes water to a newly developed area in the southwestern portion of the City near the Grenada Lake Medical Center.

CITY OF GRENADA PWS WELLS

Well #	Year Const.	Capacity (gpm)	Casing Size	Depth (ft.)
		Main Wellfield		
1	1925	N/A	10"	170
2	1928	650	12"	170
3	1944	1000	12"	170
4	1972	1000	16"	190
5	1955	600	12"	170
		Front Street Wellfield		
6	1963	600	12"	170
7	1978	1000	16"	135
		Westside Well		
8	1978	1000	16"	247

Water Use. The PWS wells furnish almost all of the potable water for domestic users, as well as a significant number of industrial users in the city. Some industries obtain their water from private on-site wells. Water use from domestic wells in areas surrounding the City is considered to be insignificant because most of these areas are already serviced by various PWS systems.

The bulk of ground water withdrawals in the Grenada area are from the Meridian-upper Wilcox aquifer, with lesser amounts being pumped from the middle and lower Wilcox aquifers. Water use from the City of Grenada PWS system is approximately 1.4 million gallons per day (mgd). Projected water use from the City's PWS system should approach 1.6 mgd by the year 2000, based on current trends.

Water Quality. A review of water quality analyses from the Mississippi Department of Health (MDOH) was performed to evaluate the occurrence of volatile organic compounds (VOCs) and metals from water samples from the City's PWS wells. This review revealed only sub-maximum contaminant level (MCL) detections of Dichloromethane in 1988 and Chloroform in 1989, byproducts of chlorination.

WHP PHASE I: HYDROGEOLOGIC ASSESSMENT

Assimilation, Development, and Use of Hydrogeologic Data

Existing Data. The initial step in a hydrogeologic assessment is the assimilation of existing hydrogeologic data. For the Grenada project, multiple sources for data were accessed, including the following:

- U.S. Geological Survey
  - Water well records
  - Pump test records
  - Electric logs
  - Published reports
- Office of Land & Water Resources
  - Driller's logs
  - Groundwater withdrawal permits
  - Water well records
  - Published reports
- Office of Geology
  - Electric logs
  - Published reports
- Department of Health
  - Well records
  - Water quality analyses
  - PWS system records
  - Water use data

New Data. In an effort to acquire site-specific information about the Meridian-upper Wilcox aquifer at Grenada, a two-well aquifer test was performed over a 37 hour period using the two wells at the Front Street wellfield. Well Number 7 was pumped continuously for over 24 hours at the average rate of 807 gallons per minute (gpm). Water level measurements from this well were taken, starting at one minute intervals and gradually increasing to one hour intervals as the aquifer began to show the effects of stabilization. At the same time and frequency, water level measurements were also taken at well Number 6, located

approximately 300 feet southwest of the pumped well. Information from this test was used to calculate transmissivity, storativity, and specific capacity for the aquifer at Grenada.

Hydrogeology of the Grenada Area

Stratigraphy of the Meridian-upper Wilcox Aquifer. The Meridian-upper Wilcox aquifer serves as the potable water source for the City of Grenada. This aquifer in northern Mississippi is comprised of the following discontinuous, yet hydraulically connected, units: (1) the Meridian sand, the basal member of the Tallahatta Formation and the Claiborne Group and (2) the upper sand deposits of the Wilcox Group (Figure 1). Overlying the Meridian-upper Wilcox sand is the Basic City shale member of the Tallahatta Formation, which serves as the overlying confining unit for the Meridian-upper Wilcox aquifer.

The Meridian-upper Wilcox sands in the area are composed of fine to coarse-grained sand. It is characterized by irregular or subrounded grains, many of which show conchoidal surfaces. White mica is abundant in the fine sand at its base. The middle part of Meridian-upper Wilcox sand interval generally contains the coarsest grains of sand, although local variations have been observed in test holes and outcrops. These coarse zones are the most permeable and exhibit higher conductivities on electric logs.

Outcrop areas of the Meridian-upper Wilcox occur as north-south trending topographic ridges situated 4 to 5 miles east of Grenada. These surficial deposits serve as points of aquifer recharge. In the Grenada area, the Meridian-upper Wilcox aquifer ranges from less than 30 feet to over 160 feet in thickness, with an average thickness estimated at 100 feet. The aquifer dips regionally to the west-southwest at the average rate of 60 feet per mile.

Aquifer Confinement. The Basic City shale is surficially exposed within the floodplain on which the City of Grenada and surrounding area exists. With an average thickness of 20 feet, this shale unit serves as the overlying confining layer for the Meridian-upper Wilcox aquifer in the area. It is composed of light gray shale, siliceous claystone, siltstone, sand, and quartzite. The shale is typically fissile and laminated, although locally thin lenses retain the structural characteristics of claystone or siltstone.

The underlying confining unit of the Meridian-upper Wilcox aquifer in the Grenada area includes undifferentiated upper Wilcox gray shales and clays. Thicknesses of this confining unit range from less than 10 feet to over 50 feet, while averaging around 30 feet in thickness in the Grenada area.

Aquifer Recharge. Recharge to the Meridian-upper Wilcox aquifer in the Grenada area occurs through infiltration of precipitation onto the exposed Meridian-upper Wilcox sands that outcrop along the topographic ridges east of the city, as well as through infiltration of fresh water contained in Grenada Lake into the aquifer sand exposed at the lake bottom.

Grenada Lake holds, on average, over 200 billion gallons of fresh water. Hydrographs indicate that since the reservoir was established during the early 1950s, water levels in wells located near the spillway have risen from pre-reservoir levels. This evidence suggests that a constant recharge is occurring as a result of the existence of the reservoir.

The average annual precipitation in the Grenada area is 52 inches, with March typically the wettest month and October the driest. Annual runoff averages 16 to 20 inches.

Potentiometric Surface

Complications of Existing Data. In the Grenada area, a significant number of water level measurements in the Meridian-upper Wilcox aquifer exist from various sources. However, limited information exists for many of the wells from which those water levels were measured. While evaluating the assimilated Meridian-upper Wilcox data, the existence of significant discrepancies in water level depths became apparent. Further evaluation revealed that the anomalous water levels generally existed in wells where a lack of supporting well data existed, particularly inadequate well location descriptions and screened intervals.

In an effort to overcome those complications, a detailed review of the data sources and supporting data for all of the anomalous water levels was performed. In addition, potentiometric surface maps were made based on incremental dates of data collection (pre-1953, 1953-1969, 1970-1985, and comprehensive). Through this effort, it was discovered that most of the problems were due to inaccurate surface elevations which were the result of inadequate well location descriptions. This data as well as data which varied significantly and lacked supporting documentation were excluded from the database from which the Meridian-upper Wilcox potentiometric map was prepared.

Hydraulic Gradient. The hydraulic gradient of the Meridian-upper Wilcox aquifer in the Grenada area was calculated using information from the prepared potentiometric surface map. A generalized hydraulic

gradient at Grenada was calculated to be 11 feet per mile (or 0.002083).

Angle of Ambient Flow. Ground water flow in Mississippi is influenced by the regional structural trend. Shallow beds in most of the state dip gently to the west-southwest toward the axis of the Mississippi River structural trough. Because of this trend, the direction of ambient ground water flow is also to the west-southwest toward the Mississippi River.

In Grenada, ground water flow follows the regional structural trend, influenced locally by recharge from the abundant water source contained in Grenada Lake to the northeast and the surficial Meridian-upper Wilcox sands exposed to direct precipitation along the topographic ridges east of the city. Regional drawdown created as the result of water use through the City's PWS wells and other industrial and nearby agricultural wells has only a minimal impact on the potentiometric surface in the Grenada area. Regional surface water drainage flows westwardly to southwardly. Through consideration of all of these factors, a conservative approach to the determination of the angle of ambient ground water flow was determined to be the best solution when considering the scope of wellhead protection. As a result, an arc of 90 degrees, due west to southwest, was selected as the direction of ground water flow in the Meridian-upper Wilcox aquifer in the Grenada area.

Aquifer Characteristics of the Meridian-upper Wilcox Aquifer at Grenada

Meridian-upper Wilcox Aquifer Test. The Meridian-upper Wilcox aquifer serves as the ground water source for the City of Grenada PWS system. Information vital for the proper characterization and delineation of capture zones for the City's public water supply wells was developed from data acquired through an aquifer test performed at the Front Street wellfield.

Transmissivity. Transmissivity (T) is the rate at which water flows through a vertical strip of the aquifer 1 foot or 1 meter wide and extending through the full saturated thickness under a hydraulic gradient of 1 (100 percent). T was calculated from the pumping rate and the slope of the time-drawdown graph by using the following relationship:

$$T = 264\ Q \div \Delta s$$

where,
Q = *pumping rate, in gpm*
Δs = *slope of the time-drawdown graph*

Using this relationship, an average transmissivity of 76,299 gallons per day per foot (gpd/ft) or 10,224 feet square per day (ft^2/d) was determined for the Meridian-upper Wilcox aquifer.

Storativity. Storativity (S) represents the volume of water released from storage, or taken into storage, per unit change in head. In unconfined aquifers, S is the same as the specific yield of the aquifer; while in confined aquifers, S is the result of compression of the aquifer and expansion of the confined water when the head (pressure) is reduced during pumping. Storativity is dimensionless. S is also readily calculated from the time-drawdown graph by using the zero-drawdown intercept of the straight line as one of the terms of the following equation:

$$S = 0.3\ Tt_o \div r^2$$

where,
T = *transmissivity*
t_o = *intercept of the straight line at zero drawdown, in days*
r = *distance, in ft., from the pumped well to the observation well*

Values of S for unconfined aquifers range from 0.01 to 0.3; values for confined aquifers range from 10^{-5} to 10^{-3}. Using the above listed formula, storativity for the MUWX aquifer was calculated to be 3.66×10^{-4}, which falls within the expected range for a confined aquifer.

Wellhead Protection Area (WHPA) Delineations

Capture Zone Models Used in Delineations. WHPAs delineated in shallow, unconfined to semi-confined aquifers in Mississippi are delineated using the time-of-travel (TOT) method, which corresponds to the average time it takes for ground water to flow to a well. The TOT method is dependent upon the pumping rates of the affected well(s), aquifer saturated thickness, screened interval, and aquifer characteristics such as transmissivity and porosity. Three ground water flow models were used in the delineation of the capture zones of Grenada's wells/wellfields. All are included in what is referred to as EPA's WHPA Code. The following three models were utilized:

RESSQC - This model can be used to delineate time-related capture zones for one or more pumping/injection wells. Well interference is accounted for in this model, and the wells are assumed to fully penetrate a homogeneous aquifer. Ground water flow must be two dimensional and steady. The aquifer may be confined or unconfined if the drawdown-to-saturated thickness ratio is small (less than approximately 20 percent).

MWCAP - This model can provide for the delineation of steady-state, time-related, or hybrid capture zones for one or more pumping wells. The effects of well interference are ignored; each well is assumed to operate independently from the others. The wells are assumed to fully penetrate a homogeneous and isotropic aquifer. Ground water flow must be two dimensional and steady. The aquifer may be confined, semi-confined, or unconfined if drawdown is approximately 20 percent or less of the saturated thickness. If a flow boundary is present, it can be incorporated into the model. The distance of the boundary is assumed to be linear and fully penetrating.

GPTRAC - The GPTRAC model consists of two major components. The "semi-analytical option" provides time-related capture zone delineation similar to RESSQC and MWCAP, and the "numerical option" provides time-related capture zone delineation through the input of hydraulic head values at nodal points of a rectangular grid. Due to data constraints, use of the "numerical option" was not considered.

The semi-analytical GPTRAC option is capable of delineating time-related capture zones for one or more pumping/injection wells. Well interference is accounted for in the model. The wells are assumed to fully penetrate a homogeneous and isotropic aquifer, and ground water flow must be two dimensional and steady. The aquifer may be confined, semi-confined, or unconfined if drawdown is approximately 20 percent or less of the saturated thickness. Stream barriers or flow boundaries can be incorporated; they are assumed to be linear and fully penetrating. If a barrier or boundary is present, it is assumed to correspond to one edge - the top, bottom, or either side of the study area.

The 90-day and 10-year capture zones for WHPA No. 0220003-A and B illustrated on the PCS Inventory/Zoning Map (Figure 2) were delineated using the semi-analytical option in GPTRAC.

Input Parameters Required by Models. Although more sophisticated groundwater flow models exist, such as MODFLOW, because of input data constraints these two-dimensional models are widely used for delineating WHPAs. Input parameters for all three WHPA models are essentially the same; however, depending on model capability, some variation does exist. The following parameters represent some of the input requirements for all three models:

Input Requirements for WHPA Code

- X and y coordinates of wells
- Transmissivity of aquifer
- Regional hydraulic gradient
- Angle of ambient ground water flow
- Aquifer porosity
- Aquifer saturated thickness
- Well discharge/recharge rate
- Time simulation
- Boundary conditions

A criticism of the WHPA code by some has been its lack of attention to the effects of drawdown. However, at Grenada, those effects were evaluated using a standard industry software program designed to address the effects of drawdown. Those results were incorporated into the hydrogeologic assessment.

Protection Zones. Mississippi's WHP program utilizes the concept of multiple protection zones in delineating and managing WHPAs. With this approach, areas closer to a wellhead are more closely managed and protected than outlying areas. In Mississippi's WHPP, three protection zones are designated within a WHPA.

ZONE 1 - At Grenada, Zone 1 consists of the areas within the security fence at the Main wellfield and Front Street wellfield, as well as the area immediately surrounding the Westside well.

ZONE 2 - Based on the confinement of the Meridian-upper Wilcox aquifer at Grenada, Zone 2 consists of 90 day time-of-travel capture zones surrounding the Main wellfield, Front Street wellfield, and Westside well.

ZONE 3 - Because of overlapping capture zones at Grenada for the Main and Front Street wellfields, the zones were combined to form one Zone 3 for both wellfields which extends from Zone 2 to the 10 year time-of-travel capture zone boundaries surrounding both wellfields. Zone 3 for the Westside well also extends from Zone 2 to the 10 year time-of-travel boundary.

WHP PHASE II: POTENTIAL CONTAMINANT SOURCE (PCS) INVENTORY

PCS Inventory Development

The Potential Contaminant Source (PCS) inventory for the City of Grenada WHP plan was performed during the first and second quarters of 1994 by staff of the Mississippi Department of Environmental Quality. Development of the PCS inventory consisted of the following elements, in sequential order:

1. Assimilation and review of in-house databases of State and EPA-regulated facilities and sites in the Grenada area

2. Performance of windshield surveys of possible PCS sites in and surrounding the WHPAs

3. Site visits to all identified sites and documentation of the PCS for each site

4. Assimilation of the PCS inventory forms and in-house regulatory program databases into a PCS ledger

5. Development of PCS Geographic Information System (GIS) database and format

6. Review of all documentation

The PCS inventory focused on those sites identified within the limits of the 10 year time-of-travel capture zones of the PWS wells/wellfields in Grenada (Figure 2). Due to the potential for industrial and population growth and its consequent increase in water demand, PCS sites adjacent to the border of the WHPAs were recorded and some of those received site visits.

Assimilation and Review of Existing Databases. Assimilation of existing databases from affected regulatory programs provided initial information on PCS sites in the Grenada area. Where a regulated facility/site existed at a specific PCS site, the in-house regulatory program databases provided basic information relative to each facility/site. Information included in these databases (depending on the database used) included addresses, contacts, facility identification numbers, site descriptions, type and volume of material storage, type and volume of material generated or discharged, assessment reviews, site status, and other pertinent information. The following regulatory programs provided database support for this portion of the PCS inventory:

Regulatory Program Database Support

- Underground Storage Tanks
- Hazardous Waste Branch (RCRA, CERCLA, and State Uncontrolled Sites)
- Nonhazardous Waste Branch
- Surface Water Branch (Pre-Treatment, NPDES, and General Permits)
- Office of Land & Water Resources (Groundwater Withdrawal Permits)
- Department of Health (Pesticide Surveys)
- MS Emergency Management Agency (SARA Tier II Reports)

Where remediation projects or sites of concern existed, a file review was performed of those projects. The file reviews yielded detailed environmental assessments, ground water quality analyses, remediation histories, and other pertinent technical data.

Windshield Surveys. The second element of the PCS inventory phase involved the performance of a windshield survey to determine those non-regulated sites which required site visits. The windshield survey also proved essential for planning for individual site visits.

Individual Site Visits. During the site visits, general questions were asked of personnel (where available) at suspected PCS sites regarding site identification (names, addresses, facility I.D. numbers, etc.). From that point, depending on the suspected PCS, site-specific questions were asked about potential contaminants existing at the site and how they were used and stored. Where possible, visual verification of this information was then performed. This information was recorded individually for each site on PCS Site Inventory forms.

PCS Identification System. After the site visits, inventoried sites were assigned unique identification numbers in preparation for the development of a Geographic Information System (GIS). These unique numbers allow data collected about a PCS site to be accessed in a variety of ways, such as PWS number, WHPA number, PCS type, PCS category, or PCS site number.

Geographic Information System (GIS) Database Development. Upon completion of Phase II activities, WHPA boundaries and PCS sites were added to a comprehensive base coverage (roads, rivers, water well and regulated facility locations, etc.). Completion of the GIS database occurred during Phase III when zoning layers were added (Figure 2).

PCS Inventory Results

Over 200 PCS sites were identified during Phase II activities. Based upon the information developed during the PCS inventory phase of the Grenada WHP plan, the following scenarios were found to be the dominant concerns in terms of potential contaminant sources of the City's PWS system:

- Above ground storage tank sites - The PCS inventory revealed that 15 ASTs existed in the city's WHPAs.

- Vehicle repair sites - Twenty-four sites were identified in the city's WHPAs

- Underground storage tank sites - Twelve USTs were found that were located in Grenada's WHPAs.

- Sites with deficient used material storage areas - The PCS inventory revealed the existence of 54 sites storing used material existed in the city's WHPAs. Of these, 36 sites exhibited material storage deficiencies.

- Environmental Remediation Projects - Two current ground water and soil remediation projects and one remediated leaking UST site are located within or adjacent to the city's WHPAs.

- Improperly abandoned water wells - The PCS inventory identified five abandoned water wells that had not been plugged. Three were located at a site where several 55 gallon drums of used oil had been overturned nearby.

- Active water wells - Over two dozen apparently active water wells were discovered during database searches from various sources. Specific locations of these wells, as well as their physical conditions, are not known.

WHP PHASE III: WHP MANAGEMENT PLAN DEVELOPMENT

Purpose

The purpose of developing the Grenada WHP Management Plan was to minimize the potential for public and private losses by adopting regulations, best management practices, public education strategy, and site specific corrective actions designed to minimize the risk of contamination to the City's ground water source.

Role of Local WHP Advisory Group

The structure of Mississippi's WHPP encourages local participation in the development of a WHP plan. A primary role in this effort involved the use of local volunteers to serve on a WHP Advisory Group. The role of this advisory group was to provide local input to the City, State, and consultants during the formulation of an implementable management strategy and plan designed to protect the areas surrounding the PWS wells from potential pollution.

A cross-section of community interests, industries, and government was recruited to serve in this important effort.

Regulatory Option: WHPA Overlay Districts Zoning Ordinance

The development of WHPA Overlay Districts under Article V of the City Zoning Ordinance has been proposed to the City of Grenada as a means of ensuring that land use activities within WHPA No. 0220003-A and B are consistent with the scope of the city's wellhead protection effort (Figure 2).

Scope of Authority. The WHPA Overlay Districts exist as geographically defined areas superimposed over existing zoning districts. Requirements of the WHPA Overlay Districts are in addition to the existing zoning requirements and apply only to new construction, reconstruction, or expansion of existing buildings or facilities and new or expanded uses. The scope of authority does not supersede related State or Federal regulations.

Use of Multiple Protection Zones. The concept of multiple protection zones, with graduated levels of protection according to the distance from the wellbore or center of the wellfield, has been incorporated into the proposed WHPA Overlay Districts Zoning Ordinance. These graduated levels of protection were detailed through the use of Performance Standards within the ordinance.

Performance Standards for All Protection Zones. The following requirements were enacted through the WHPA Overlay Districts Zoning Ordinance for all protection zones within the City's WHPAs:

- All property owners on whose land is sited an active or abandoned water well are required to register each well with the City.

- Construction of all new water wells shall meet existing state regulations.

- Plugging of abandoned water wells shall meet existing state regulations.

- Discharge of industrial process water on site is prohibited without obtaining City and State approval.

- Open liquid waste ponds and community wastewater treatment lagoons will not be allowed without a synthetic liner underlying the site, as well as secondary containment surrounding the site.

- New landfills and land application sites are prohibited.

- All inactive UST containment must assess the site for contamination and permanently closed by a certified contractor.

- Above ground storage of gasoline, diesel, or used petroleum products in quantities exceeding 55 gallons at a site must be contained in above ground storage tanks (ASTs) with secondary containment systems. Registration of such tanks with the city is required.

- Drums and containers of any potential contaminant must be stored off of the ground on an impermeable surface.

- Auto service, repair, or painting facilities and junk and salvage yards shall meet all Federal, State, and local standards and requirements for the storage, handling, and disposal of waste products, and shall properly dispose of all other potentially hazardous waste materials.

- Storage of commercial fertilizers and pesticides is not permitted unless such storage is within a structure designed to prevent the generation and escape of contaminated runoff or leachate.

Additional Performance Standards for Protection Zone 1. In addition to the above-described requirements for all protection zones, the following activities are prohibited within Zone 1:

- All activities that may result in groundwater contamination, such as the storage, handling, use, or production of any regulated substances.

- Organic substances and fuel storage, except that associated with diesel generators.

Additional Performance Standards for Protection Zone 2. In addition to the previously-described requirements for all protection zones, the following additional performance standard is required within Zone 2:

- New underground storage tank (UST) systems must have secondary containment (double-walls) on the tanks and lines.

Enforcement and Penalties. An enforcement notification and reconciliation process was recommended to the City in the event violations to the proposed ordinance are reported. The recommendation included establishing penalties as well as a corrective action process.

Site Plan Review. Modification of the existing Site Plan Review Ordinance requirements to include any residential, commercial, or industrial development within the WHPA Overlay District was recommended for adoption by the City.

Non-regulatory Options

Groundwater Monitoring. Two types of mandatory groundwater monitoring activities routinely occur in the City of Grenada. Both activity types are required by existing EPA programs designed to protect the public health of residents of the Grenada area. These activities are:

PWS Monitoring - This type of monitoring involves sampling all PWS wells to determine compliance with the Safe Drinking Water Act. The PWS well monitoring program is administered by the MDOH to ensure that Maximum Contaminant Levels (MCLs) for inorganic chemicals, volatile organic chemicals (VOCs), and nonvolatile synthetic organic chemicals (SOCs), as established by the EPA, are not exceeded.

Source Monitoring - This type of monitoring involves groundwater sampling near specific point sources of contamination. Source monitoring at present is conducted at UST, LUST, CERCLA, and RCRA sites and is monitored by those programs at the MDEQ.

Water Conservation. The City of Grenada was encouraged to use best water management practices as part of its WHP public education efforts. It was recommended that those practices should include prudent measures designed to reduce unnecessary water consumption, such as the adoption of a local plumbing code that specifies low water use accessories in all new construction and replacement efforts. In addition, the City was encouraged to minimize water loss from its distribution system due to leakage.

Household Hazardous Waste Disposal. The City was encouraged to consider applying for available funding to conduct Household Hazardous Waste Collection Days on a recurring schedule.

Public Education. The City was encouraged to recognize the desirability of actively promoting and participating in specific efforts designed to educate the citizens of Grenada regarding groundwater quality and wellhead protection issues.

Site Specific Corrective Actions

Based upon existing conditions found as a result of the PCS Inventory process, the following corrective actions for specific site categories within the WHPAs have been proposed. The corrective actions for those specific sites were placed in the following generalized categories.

Abandoned Water Wells. The proposed WHPA Overlay District Zoning Ordinance requires all water wells - abandoned, existing, and new - to conform with MDEQ-OLW *Surface Water and Groundwater Use and Protection Regulations*. The ordinance also requires all wells, regardless of size or use, to be registered with the city.

Closed Landfills. The City should inform water well registrants about the locations of the two closed sites. The City should coordinate proposed activities around these sites with the MDEQ.

Environmental Assessments and Remediation Projects. The MDEQ will notify the appropriate State ground water programs about the delineated WHPAs.

Abandoned Septic Tanks. The City should verify the existence of these sites and make sure that every abandoned septic tank is closed according to MDOH regulations.

Underground Storage Tanks. All USTs should be in compliance with MDEQ UST program requirements and the proposed WHPA Overlay District Zoning Ordinance.

Above Ground Storage Tanks. Secondary containment systems capable of holding adequate releases of product are required for a site where above ground storage of liquid petroleum products exceeds 55 gallons. Registration of such tanks with the City is also required.

Chemical Storage Facilities/Containers. The City should notify the appropriate State agencies of violations in existing Federal and State laws for the storage and transport of used waste materials. The City also should notify the owners of those facilities/containers of the Performance Standards contained in the WHPA Overlay District Zoning Ordinance for storage of liquid petroleum products and storage of commercial fertilizers and pesticides.

Drums and Containers. Storage of drums and containers containing 55 gallons or less of potentially polluting constituents must be stored off of the ground on paved or impermeable surfaces.

Illegal Dumping. The City will stop any illegal dumping on its property and will patrol other areas where dumping has occurred citing violators accordingly.

Auto Service, Repair, and Painting Facilities/Junk and Salvage Yards. The City will ensure that compliance of these facilities is maintained with existing zoning ordinances and proposed WHPA Overlay District Zoning Ordinance. The City will report any known violations of federal or state law regarding the storage, handling, and disposal of petroleum products to the appropriate agencies.

Cemeteries. The City will inform water well registrants about the locations of the cemeteries in its WHPAs.

Public Participation

When comments on the proposed WHP Management Plan are received from the City, the proposed plan and comments will be reviewed by the local WHP Advisory Group for its input. Once that process is completed, a revised plan will be presented at a public hearing that will be held for the purpose of seeking input and comments from the general public. Comments and recommendations generated at the hearing will be considered for inclusion in the final plan.

Contingency Plan

A local WHP Contingency Plan is being developed for the purpose of establishing a structure and source of essential information that will allow the City to respond effectively to events that could contaminate or affect the utility of the City's public water supply. The plan contains information about potential sources of contamination, identifies agencies that should be notified in case of potential contamination of water quality or interruption of service, describes procedures for responding to various types of events, and discusses the alternatives for short-term and long-term responses.

The contingency plan references and supplements Grenada County's existing *Comprehensive Emergency Management Plan* as well as the MDOH's *Emergency Plan for Community Water Supplies*.

CONCLUSION

As the initial WHP demonstration project in the State, the City of Grenada has taken a leading role in the development and implementation of the concept of Wellhead Protection. As a result, the City should enjoy significant benefits offered by the program, including the following:

- Protection of a resource vital to the private, industrial, and public needs of the community at a minimal cost.
- Substantial potential cost-savings as a result of the reduced risk of PWS system contamination and costly well replacement and/or aquifer remediation.

- Development of valuable hydrogeologic information that could prove useful in assessing Grenada's ability to meet current and future PWS needs, well interference that might exist between wells, and optimum locations for future wells.

- Local administration and management

- Community involvement and public education through a "grass-roots" environmental approach.

Development of this local WHP plan has also yielded a significant benefit to the State by providing a blueprint for the development of other local WHP plans throughout the State. Numerous forms, strategies, and methodologies were developed to address the individual phases of the project, as well as the overall concept.

Wellhead Protection is alive in Mississippi! Through the voluntary assistance of Grenada municipal personnel and residents, the entire State will benefit from the hard work performed in this local effort.

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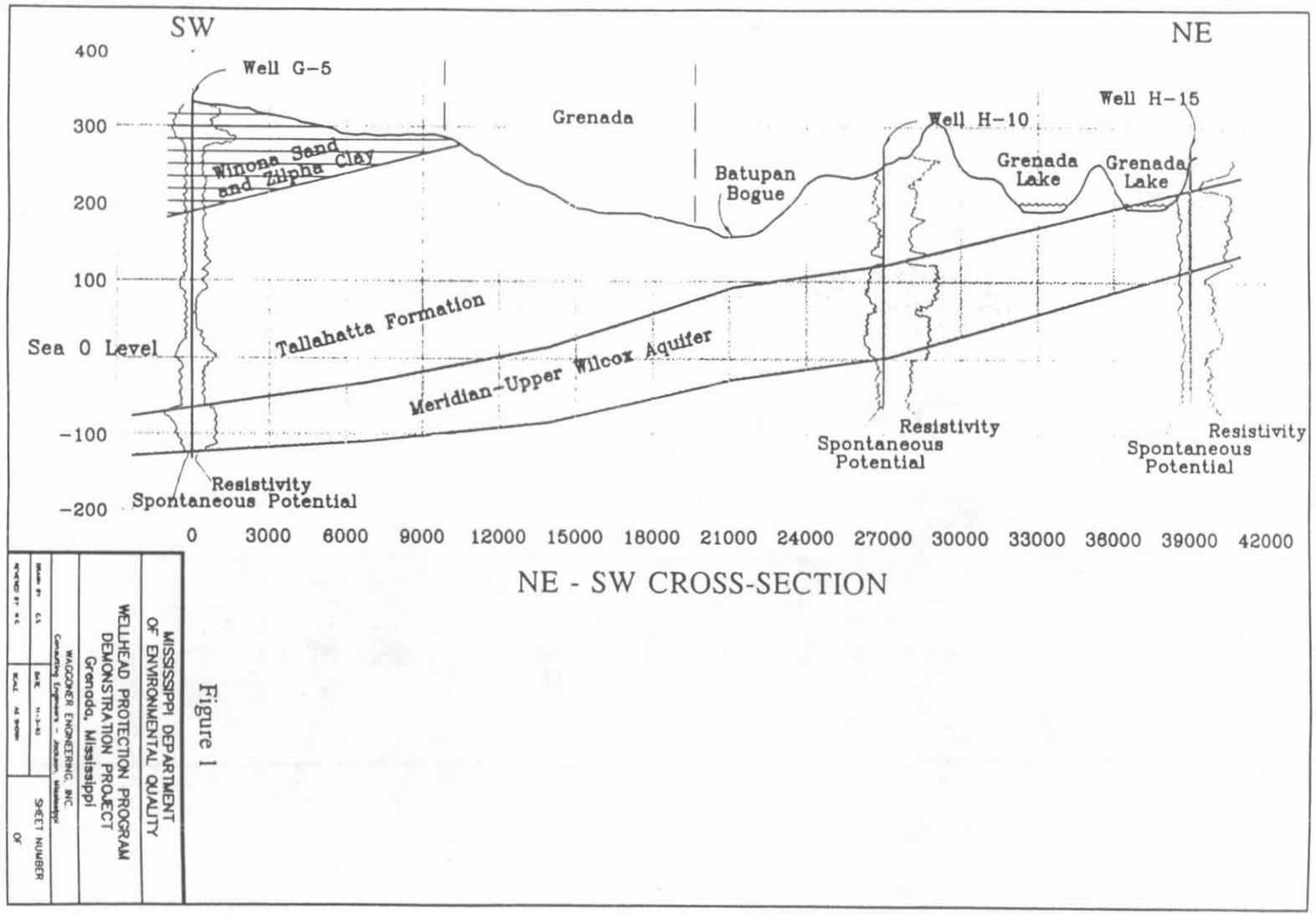
SW
NE
400
300
200
100
Sea 0 Level
-100
-200
Well G-5
Grenada
Batupan Bogue
Well H-10
Well H-15
Grenada Lake
Grenada Lake
Winona Sand and Zilpha Clay
Tallahatta Formation
Meridian-Upper Wilcox Aquifer
Resistivity
Spontaneous Potential
Resistivity
Spontaneous Potential
Resistivity
Spontaneous Potential
0
3000
6000
9000
12000
15000
18000
21000
24000
27000
30000
33000
36000
39000
42000
NE - SW CROSS-SECTION
MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY
WELLHEAD PROTECTION PROGRAM
DEMONSTRATION PROJECT
Grenada, Mississippi
WAGGONER ENGINEERING, INC.
SHEET NUMBER
OF

Figure 1

Figure 2
PCS INVENTORY/ZONING MAP - CITY OF GRENADA