Missouri Statewide Groundwater Restoration Plan

May 2015

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SECTION 1 – INTRODUCTION

1.1 General Information

The Missouri Statewide Groundwater Restoration Plan (Plan) establishes and guides the implementation of restoration and protection projects that address injuries to the state's groundwater resources. Under both state and federal law, the State of Missouri, acting on behalf of the public as Trustee for natural resources, has the authority to recover monetary or other damages from parties responsible for injuries to natural resources resulting from the unlawful release of hazardous substances and/or pollutants (collectively, "contaminants").

Based on those legal authorities and in response to identified contamination at sites throughout Missouri, the Missouri Department of Natural Resources ("Department") recovered natural resource damages through the bankruptcy and related litigation involving Tronox and Anadarko. Detailed information about this litigation is available at http://www2.epa.gov/enforcement/case-summary-tronox-incorporated-bankruptcy-settlement**.** Creosote used in industrial wood treatment processes was the primary source of contamination. This Plan is intended to guide future expenditures of not only these funds, but also other or future damage recoveries involving groundwater injuries in Missouri.

Following publication of this Plan, the Department will use the recovered damages and any future damages recovered to implement restoration projects designed to restore, protect and preserve the state's groundwater resources. Natural resource damages received, either through litigation or negotiated settlements, must be used to restore, replace, rehabilitate, and/or acquire the equivalent of those natural resources injured and natural resource services lost. This Plan summarizes the current environmental setting and describes the purpose and need for restoration actions.

The purposes of this Plan are to:

1) Provide a planning tool for the restoration of groundwater resources using recovered damages;

2) Minimize the time between recovering damages and implementing restoration projects;

3) Provide information to interested parties regarding potential restoration actions;

4) Provide a restoration plan in compliance with any applicable federal requirements; and,

5) Utilize natural resource damage recoveries in connection with other funding streams to produce larger benefits to the public.

This Plan is not intended to (1) identify specific projects or (2) identify specific recipients of restoration funds, though it is intended to convey the general purpose and identify potential categories of projects.

Definitions

Natural resources include: land, fish, wildlife, biota, air, water, groundwater, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise entrusted to the state.

Services include:

- *Ecological services*—the physical, chemical, or biological functions that one natural resource provides for another. Examples include provision of food, protection from predation, and nesting habitat, among others; and

- *Human services*—the human uses of natural resources or functions of natural resources that provide value to the public. Examples include drinking water, irrigation, fishing, recreation, nature photography, and education, among others.

In considering both natural resources and services, the Department is addressing the physical and biological environment and the relationship of people with that environment.

Injury: an adverse change, loss, degradation or reduction of the viability of groundwater or other associated biotic and non-biotic resources linked to its human use and ability to support ecosystem function due to releases of contaminants.

Groundwater resources: the water beneath the surface of land and the aquifers, rocks, or sediments through which groundwater moves, including contaminant conduits to the subsurface, karst features (including losing streams, sinkholes, and caves), groundwater recharge zones, and other related features affecting groundwater.

1.2 Scope and Scale of the Missouri Statewide Groundwater Restoration Plan

This Plan is designed to be flexible, allowing existing and future recovered natural resource damages to be used to implement restoration projects. This Plan is intended to apply to all releases, discharges, spills or other incidents, occurrences, or events (hereinafter referred to as "events") which impact groundwater resources of the State of Missouri and give rise to claims for natural resource damages under the authorities listed in Section 1.3 below. This Plan is not intended to quantify the extent of restoration needed at any particular site. The Department reserves the right to modify this Plan as necessary in accordance with the procedures in Section 5.2.

1.3 Authority and Legal Requirements

Under both state and federal law, the state has the authority to hold parties liable for injuries to natural resources resulting from the release of contaminants. The primary authorities relied upon by the state include the federal the Comprehensive Environmental Response, Compensation, and

Liability Act ("CERCLA") [42 U.S.C. Sections 9601-9675] and the Missouri Clean Water Law ("Clean Water Law") [Chapter 644 RSMo].

CERCLA requirements

CERCLA authorizes the Governor of the State of Missouri to act as "Trustee" on behalf of the public, and to restore, rehabilitate, replace and/or acquire natural resources equivalent to those injured by releases of hazardous substances. Under that authority, the Governor designated the Director of the Missouri Department of Natural Resources as the Trustee for the state's natural resources (for purposes of this Plan, the use of the word "Trustee" and "Department" are the same). As the designated state Trustee, the Director and Department staff conduct natural resource damage assessments, complete restoration planning, and implement restoration projects. Specific CERCLA requirements about how recovered damages may be spent include:

1. That recovered sums are used to "restore, replace, or acquire the equivalent of such [injured] natural resources." 42 U.S.C. Section 9607(f)(1).
2. That before funds are used for restoration, a plan "for the use of such funds for such purposes has been developed and adopted by…the Governor…after adequate public notice and opportunity for hearing and consideration of all public comment." 42 U.S.C. Section 9611(i).

Clean Water Law requirements

Under state law, Section 644.096 RSMo authorizes the State of Missouri to bring a cause of action against any person violating the provisions of the Clean Water Law for actual damages, including costs and expenses to restore waters of the state to the condition that existed prior to the violation.

This Plan is intended to address natural resource damage claims or restoration efforts relating to injured groundwater for recovered funds that may be subject to any federal requirements for a restoration plan and that are not being addressed under other plans involving federal co-trustees. Other restoration plans exist for the southeast and southwest portions of the state, called the Southeast Missouri Ozarks Regional Restoration Plan and the Springfield Plateau Regional Restoration Plan, respectively. Those plans may be found on the Department's website: dnr.mo.gov/env/hwp/sfund/nrda.htm.

1.4 Importance of Groundwater Resources

Groundwater is one of Missouri's most vital natural resources. Missouri has significant, high-quality groundwater resources that the Department is charged with protecting from potential contaminants and safeguarding for current and future uses.

The state's geology is composed mostly of sedimentary rocks like sandstone and fractured limestone and dolomite. These strata serve as substantial groundwater reservoirs. Because of this, much of Missouri contains an abundance of fresh, drinkable groundwater available for use.

Missouri's groundwater resources vary greatly across the state and are tied closely to the geology of the various regions. To assess Missouri's groundwater resources, the state has been divided

into seven major groundwater provinces and two subprovinces (Figure 1). Boundaries of the groundwater provinces are drawn based on several factors including aquifer characteristics, groundwater quality changes, and aquifer boundaries. It is important to note that the province boundaries do not represent groundwater divides; aquifers, and thus local and regional groundwater flows, can and do cross the various groundwater provinces. Major groundwater provinces include the St. Francois Mountains, the Salem Plateau, the Springfield Plateau, West-Central Missouri, Northwestern Missouri, Northeastern Missouri, and Southeastern Lowlands. The Mississippi River alluvium and the Missouri River alluvium are treated as sub-provinces.

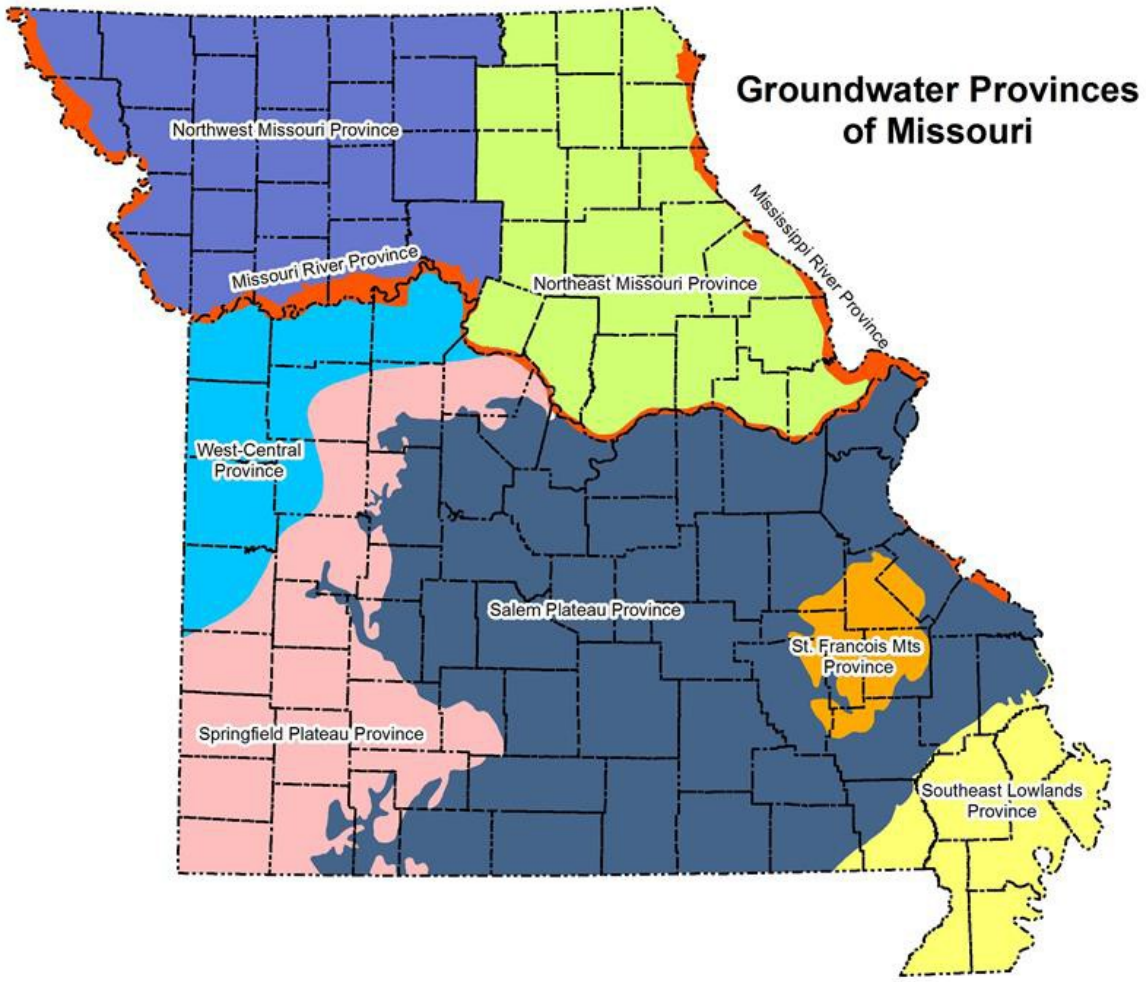

FIGURE 1. GROUNDWATER PROVINCES OF MISSOURI

St. Francois Mountains Groundwater Province

The St. Francois Mountains Groundwater Province lies in parts of seven counties covering 1,300 square miles (mi^2) in southeastern Missouri. It is estimated that this province contains 919 billion gallons of usable groundwater. The principal source of groundwater is the St. Francois aquifer, predominately composed of dolomite and sandstone. However, this province is also characterized by occurrences of granite and rhyolite. Recharge for the St. Francois aquifer,

which is exposed at the surface over much of the province, comes from precipitation that falls on the exposed aquifer formations and percolates to the subsurface.

Salem Plateau Groundwater Province

The Salem Plateau Groundwater Province includes all or part of 49 counties, an area of about 24,760 mi^2. It is estimated that this province contains 232 trillion gallons of usable groundwater, making it the largest source of usable groundwater in Missouri. The principal source of groundwater in this province is the Ozark aquifer, predominately composed of dolomite with some sandstone units. However, the St. Francois aquifer also is present below the Ozark and is utilized to a lesser extent. This province is characterized by many karst features, including caves, large springs, sinkholes, and losing streams. Recharge for the Ozark aquifer results from precipitation that falls on the exposed aquifer formations and moves to the subsurface slowly by percolation or quickly via karst features. Recharge for the St. Francois aquifer in this province occurs from subsurface movement of groundwater from the St. Francois Mountains Province as well as communication between the Ozark and St. Francois aquifers through a leaky confining unit.

Springfield Plateau Groundwater Province

The Springfield Plateau Groundwater Province includes all or part of 27 counties, an area of about 8,900 mi^2. It is estimated that this province contains 122.5 trillion gallons of usable groundwater. While the Ozark aquifer is the principal source of groundwater, two additional aquifers can be utilized. The uppermost aquifer is the Springfield Plateau aquifer, which consists predominantly of limestone. The lowermost aquifer is the St. Francois, which currently is utilized only by large public water supply wells. As is the case in the Salem Plateau Province, the Springfield Province is characterized by karst features such as caves, large springs, sinkholes, and losing streams. Recharge for the Springfield Plateau aquifer in this province results from precipitation that falls on the exposed aquifer formations and moves to the subsurface slowly by percolation or quickly via karst features. Recharge for both the Ozark and St. Francois aquifers in this province occurs from subsurface movement of groundwater from areas to the east, where the aquifers are exposed at the surface, as well as communication between the aquifers through leaky confining units.

West-Central Missouri Groundwater Province

The West-Central Missouri Groundwater Province includes all or part of 12 counties, an area of about 5,080 mi^2. It is estimated that this province contains 1.2 trillion gallons of usable groundwater. Four hydrologic units are present in this province. The uppermost Pennsylvanian (Western Interior) confining unit consists of limestone, sandstone, shale, and coal. The Springfield, Ozark, and St. Francois aquifers are below the confining unit, but may be highly-mineralized. These aquifers may be utilized near the eastern border of the province, but become unusable (without further treatment) near the Kansas state line. Some locations may produce suitable quality and quantity of water for domestic uses from shallow limestone or sandstone units of the confining unit. What little recharge occurs in the Pennsylvanian confining unit results from slow percolation of precipitation. Recharge for the Springfield, Ozark, and St.

Francois aquifers occurs from subsurface movement of groundwater from the east, where the aquifers are exposed at the surface, as well as communication between the aquifers through leaky confining units.

Northwestern Missouri Groundwater Province

The Northwestern Missouri Groundwater Province includes all or parts of 23 counties, an area of about 12,117 mi^2. It is estimated that this province contains 10.2 trillion gallons of usable groundwater. The vast majority of the usable groundwater resides in areas of high sand and gravel content within thick glacial drift (which is predominantly clay) and alluvial deposits of many streams in northwest Missouri. The Pennsylvanian confining unit, Mississippian aquifer (Springfield Plateau aquifer equivalent), and Cambro-Ordovician aquifer (combined Ozark and St. Francois aquifers equivalent) all underlie this province. Because of the clay in the glacial materials and shale in the confining unit, the amount of vertical movement of recharge water is very minimal. This results in stagnant and highly-mineralized bedrock groundwater in these three aquifers. Therefore, the groundwater from the Mississippian and Cambro-Ordovician aquifers in this province is not considered usable. Some locations within the province may produce suitable quality and quantity of water for domestic uses from shallow limestone or sandstone units of the confining unit.

Northeastern Missouri Groundwater Province

The Northeastern Missouri Groundwater Province includes all or part of 21 counties, an area of about 11,708 mi^2. It is estimated that this this province contains 67.6 trillion gallons of usable groundwater. As is the case in northwestern Missouri, part of this province is overlain by glacial drift and units of the Pennsylvanian confining unit, resulting in highly-mineralized groundwater in the Mississippian and Cambro-Ordovician aquifers. However, the glacial drift and confining unit thins in the southern portion of this province. Here, the bedrock aquifers produce useable groundwater. As in the Northwestern Province, the glacial drift and shallow bedrock limestone and sandstone units may produce small amounts of potable groundwater for domestic uses.

Southeast Lowlands Groundwater Province

The Southeast Lowlands Groundwater Province includes all or part of 10 counties, an area of about 3,916 mi^2. It is estimated that this province contains 73 trillion gallons of usable groundwater. Four aquifers underlie this province. The uppermost aquifer is alluvial sand and gravel, which covers the entire province except the upland ridges. South and east of the ridge, under the alluvium, is the Wilcox aquifer, also composed of sand and gravel. These two aquifers are unconfined and lie in direct connection with the surface. Between the Wilcox and the next aquifer, the McNairy Sandstone, lies a thick confining layer of clay, except where the McNairy is exposed in the northern portion of the ridge. Below the McNairy is the Ozark aquifer, utilized only in the northern portion of the province, north and west of the ridge. Recharge for the Alluvial and Wilcox aquifers is from percolation of precipitation. Because the confining unit above the McNairy lets very little water through, nearly all of the sandstone's recharge occurs where the unit is exposed at the surface. Recharge for the Ozark Aquifer mostly occurs in the

uplands of the Salem Plateau Province to the north, with a small amount of recharge where the alluvium overlies the aquifer.

Mississippi and Missouri River Alluvial Aquifers

These sub-provinces occupy a relatively small area of Missouri: 485 mi^2 for Mississippi River alluvium and 1,401 mi^2 for Missouri River alluvium. It is estimated that these sub-provinces contain 4.5 trillion gallons of usable groundwater. The aquifer is composed of unconsolidated sand and gravel deposits. Recharge occurs from precipitation and direct hydrologic communication between the aquifer and the river, with a minor amount from the underlying bedrock.

Recharge of groundwater

As described above, recharge of groundwater resources can occur in several ways, often depending on location and the aquifer. Most Missouri groundwater originated as, and is replenished by, precipitation. In areas where the aquifer is unconfined (meaning the aquifer is relatively close to the surface and there are no impermeable barriers, or confining layers, preventing downward migration of fluids from the surface into the aquifer), water from precipitation can move downward and recharge the aquifer very quickly. In areas where the aquifer is deeper and overlain by low-permeability strata, or confining units, (i.e., a confined aquifer) recharge generally is much slower, often occurring at a great distance from the source of recharge. For example, the Springfield Plateau Groundwater Province in southwest Missouri (Figure 1) contains three significant aquifers: the Springfield Plateau aquifer, the Ozark aquifer and the St. Francois aquifer. The uppermost aquifer, the Springfield Plateau aquifer, primarily is recharged by precipitation. However, the lowermost St. Francois aquifer receives recharge from the St. Francois Mountains located over 100 miles to the east. Recharge also can occur between aquifers through interchange of water through leakage upward and/or downward. In addition, karst features, such as losing streams (Figure 2) and sinkholes (Figure 3), can serve as recharge features that rapidly funnel large quantities of surface water underground.

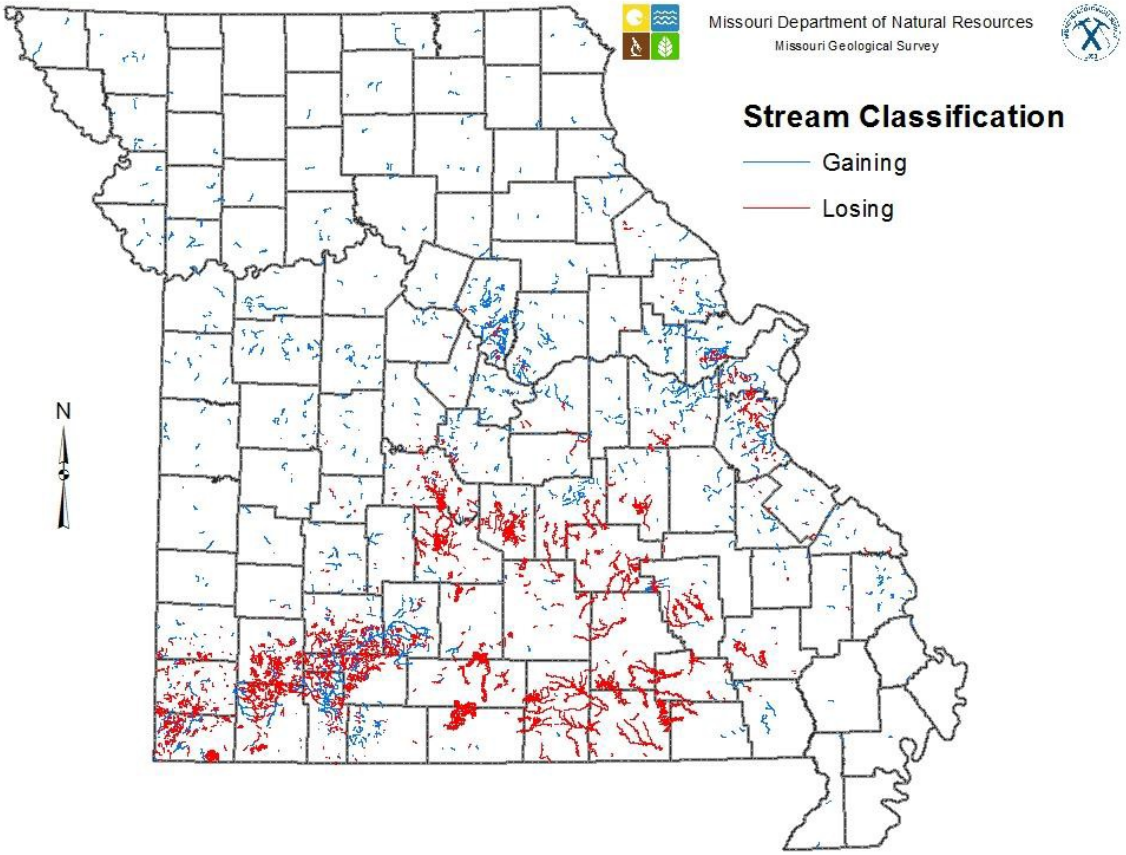

FIGURE 2. LOSING/GAINING STREAMS OF MISSOURI

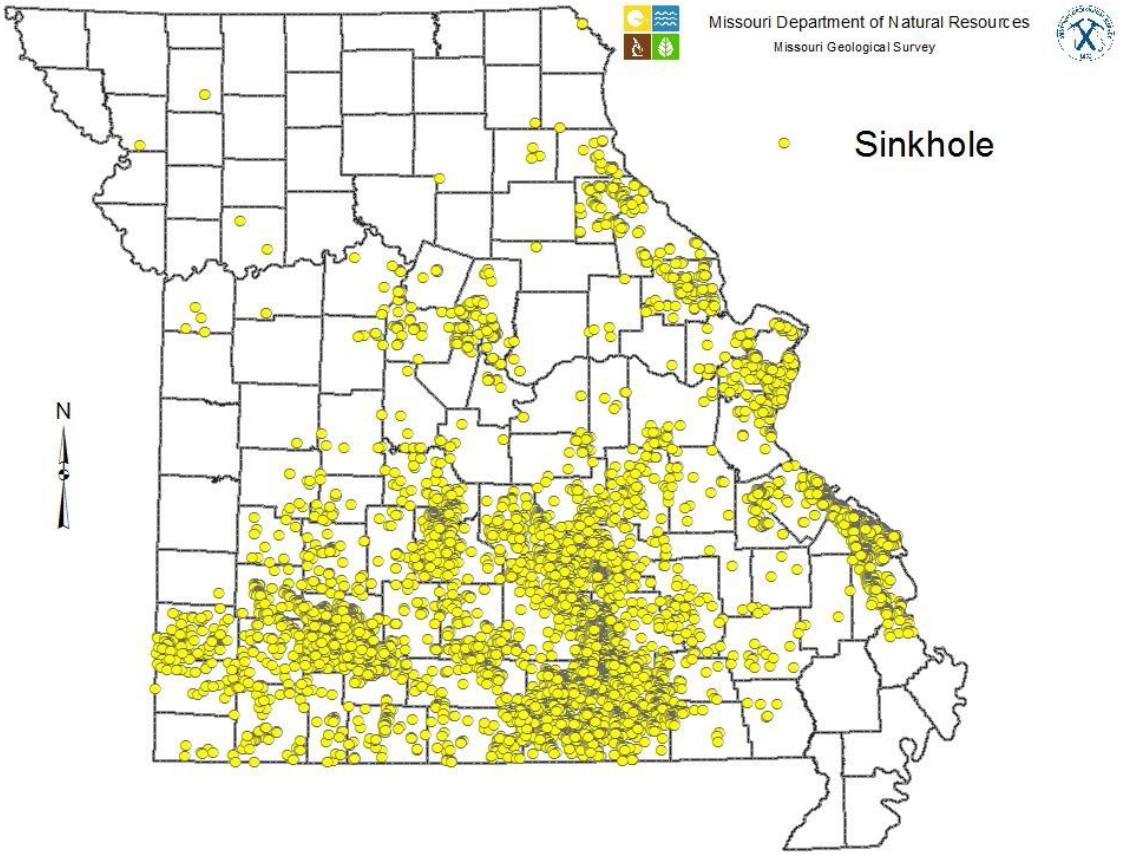

FIGURE 3. KNOWN SINKHOLES OF MISSOURI

Usage of groundwater

Missourians use groundwater for drinking, food production, cleaning, cooling, heating, manufacturing and recreation. The natural beauty of water is the central focus in many of the state's parks and historic sites, and a focus area of protection for the Department, including many large springs where groundwater discharges to surface water and greatly enhances surface water resources.

Several billion gallons of groundwater are pumped from the state's geologic formations and alluvial deposits every year, and the demand likely will increase. Missouri has nearly 160,000 registered water wells, of which about 85% are private domestic water wells. Each year, approximately 3,100 private domestic water wells are drilled. Municipalities and businesses in the state operate more than 4,300 public wells, some supplying as much as 2 million gallons of water each day.

Ecological resources found in association with caves and karst aquifers include not only the waters themselves, but also the sensitive and unique biological communities they support. Karst features may support a variety of species, some of which occur only in individual caves or cave

systems. About 1,038 (17%) of Missouri's 6,200 caves (Figure 4) and springs (Figure 5) support at least one cave species. Over 900 species have been recorded in association with Missouri cave systems, many of which are found nowhere else on earth. The existence of complex surface and underground cave features also makes the ecology of karst systems complex, highly variable and unique, and more susceptible to groundwater contamination.

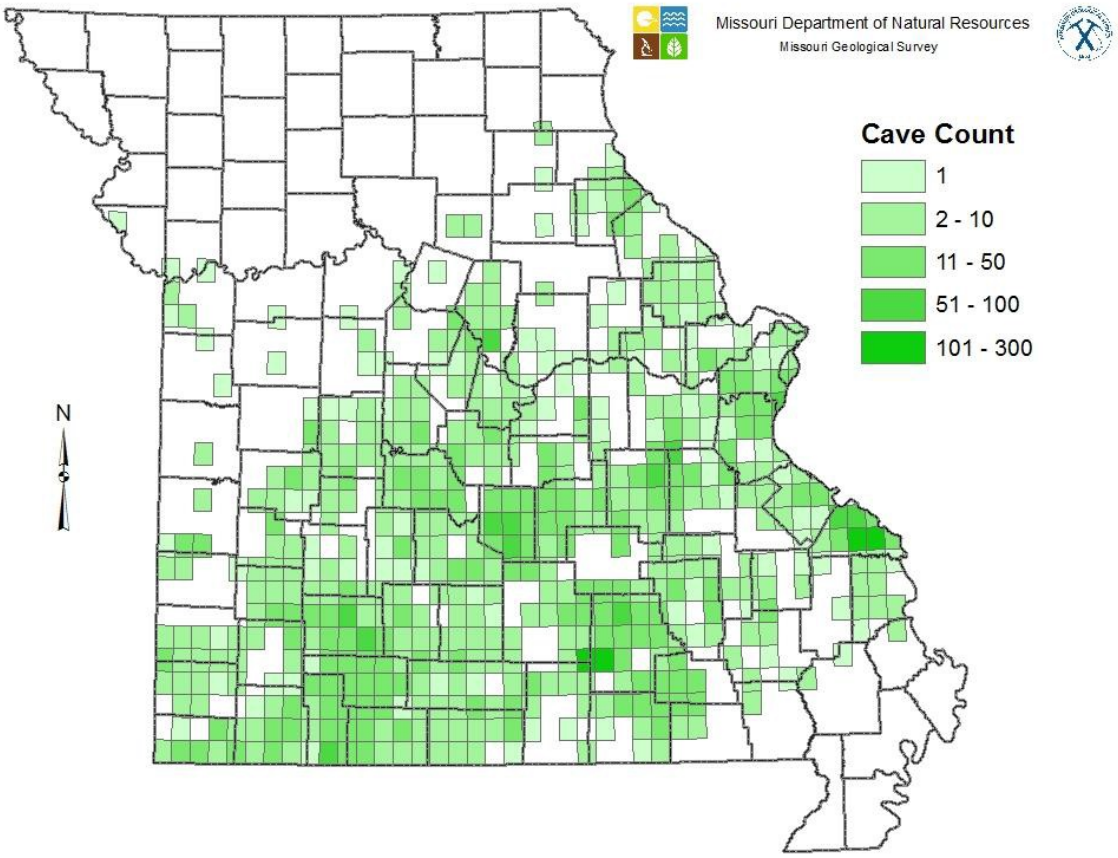

FIGURE 4. CAVE DENSITY IN MISSOURI

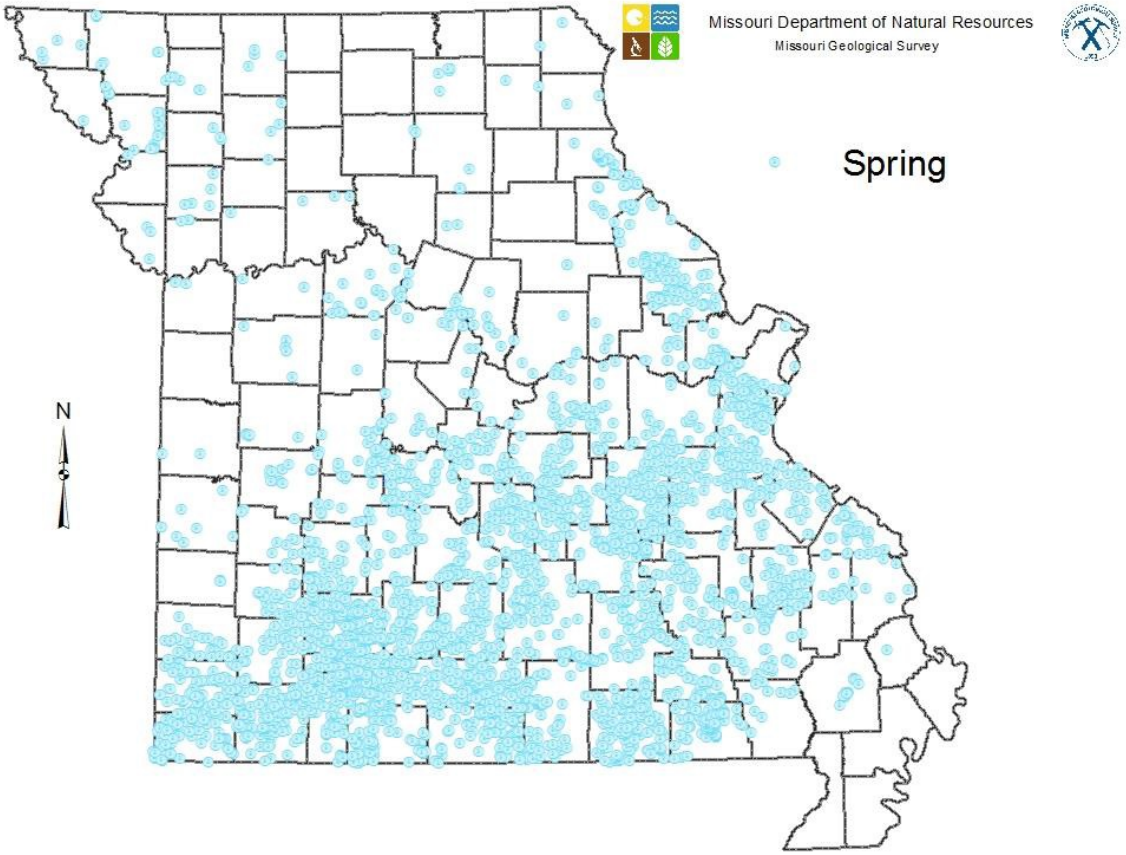

FIGURE 5. KNOWN SPRINGS OF MISSOURI

1.5 Potential Contaminant Pathways

The releases of contaminants can impair groundwater quality as well as karst and cave resources through various conduits. For example, groundwater resources may be affected by direct inflow of contaminants through unplugged water wells or oil/gas wells, sinkholes, losing streams, abandoned underground mines and shafts, as well as other conduits. Contaminants entering karst features can move rapidly into groundwater, flowing through solution-enlarged fractures, conduits, and cave openings and ultimately surfacing in springs. Groundwater resources also may be affected by seepage and percolation of contaminants from un-reclaimed and abandoned surface and underground mining, industrial releases from leaking above or underground tanks or storage pits, or releases due to dumping or accidental spills.

SECTION 2 – NEED FOR RESTORATION

As discussed above, this Plan contemplates groundwater restoration projects targeted at addressing releases of contaminants to groundwater and to preserve and protect uncontaminated groundwater areas. As discussed in Section 1.5, there are numerous conduits to groundwater including direct, in the case of sinkholes or unplugged or improperly constructed wells, and indirect pathways, in the case of seepage or percolation.

Natural resource restoration may include primary and/or compensatory restoration projects:

Primary restoration consists of any action taken to return an injured natural resource and its services to its baseline (pre-release) condition. Restoration projects that directly restore natural resource injuries caused by the release of contaminants are considered primary restoration. An example of primary restoration is the removal of contaminated materials from an ecosystem, or other actions to improve the quality of an impaired ecosystem.

Compensatory Restoration consists of any action taken:

To offset the interim losses of natural resources that occur from the date of the release until recovery; or

To acquire equivalent resources that provide the same or substantially similar services to those provided by the injured resources prior to injury.

Compensatory restoration projects do not always take place at the location of the original injury. An example of compensatory restoration is protection through acquisition of high-quality groundwater recharge areas to compensate for injuries to groundwater resources that occurred elsewhere.

For purposes of measuring restoration success, the Department plans to monitor and report on restoration projects following implementation.

2.1 Environmental Response Actions and Relationship to Natural Resource Injury

Contamination of groundwater may result in formal actions, known as “response actions,” by federal or state government environmental agencies which focus on controlling exposure to released hazardous substances by removing, neutralizing, or isolating the substances in order to protect human health and the environment from the threat of harm. Response actions are generally driven by calculated risks of exposure to humans or other environmental receptors.

While response actions can reduce the injury to the natural resource and thus reduce the need for restoration, residual natural resource injuries often remain after the conclusion of the risk-based response processes. Potential restoration activities under this Plan may augment such response actions in order to specifically address ongoing injuries to natural resources.

SECTION 3 – IDENTIFYING AND IMPLEMENTING RESTORATION PROJECTS

3.1 Important Considerations in Identifying and Implementing Restoration Projects

The Department will consider the following factors when selecting restoration projects:

1) Technical feasibility (*i.e.*, whether it is possible to implement the project);
2) The relationship of the expected costs of the proposed actions to the expected benefits from the restoration, rehabilitation, replacement, and/or acquisition of equivalent resources;
3) Other funds or partnerships that may be combined to increase the benefit of the restoration projects;
4) The connection of the restoration project to the injury;
5) The results of actual or currently planned response actions;
6) The potential for collateral injury to the environment if the project is implemented;
7) The ability of the natural resources to recover with or without each project, and the need for primary restoration;
8) Compliance with applicable federal and state standards; and
9) The duration of the restoration benefit (*i.e.* projects that produce lasting benefits may receive greater consideration).

The selected restoration projects should restore, rehabilitate, replace and/or acquire the equivalent of those natural resources and services injured by the release of contaminants into the groundwater of the State of Missouri.

3.2 Possible Restoration Projects

Possible restoration projects include, but are not limited to:

- Restore injured groundwater, caves, springs, and karst systems;
- Preserve groundwater, caves, springs, and karst systems by acquiring land for parks or for other public uses; or by acquiring conservation easements;
- Eliminate conduits or pathways for contamination, via projects such as well plugging;
- Implement water (dye)-tracing studies related to natural resources restoration efforts;
- Fund groundwater conservation projects;
- Implement riparian restoration opportunities along losing streams;
- Protect recharge areas/establish groundwater protection zones;
- Remove contaminated materials in the groundwater and their sources; and
- Educate the public about the importance of groundwater quality in Missouri.

In implementing or selecting restoration projects, the Department has no intent to utilize eminent domain or otherwise force property owners to participate in a restoration project. Participation in such projects will be voluntary.

3.3 Contracting Requirements

As the Department implements restoration projects and reviews the results of such efforts, other state agencies or outside entities may be utilized for project implementation. The Department will follow all applicable state contracting and/or procurement requirements.

SECTION 4 – RESTORATION REVIEW FOLLOWING SELECTION AND IMPLEMENTATION

4.1 Performance Standards

The Department will approve a Project Plan for each project selected under this Plan. The Project Plan may include management/restoration goals and objectives, interim maintenance schedule, monitoring schedule, and a budget including all anticipated expenses. The Project Plan will be developed concurrently with the selection of a restoration project, and will establish metrics by which the project success will be measured.

SECTION 5 – ADMINISTRATIVE RECORD AND AMENDMENTS TO THE PLAN

5.1 Administrative Record

An administrative record will be maintained by the Missouri Department of Natural Resources in Jefferson City, Missouri. Documents relating to the restoration will be cataloged, and an index will generally be available on the Department's website: dnr.mo.gov/env/hwp/sfund/nrda.htm. Documents are also available to the public upon request pursuant to Missouri's Sunshine Law, Chapter 610, RSMo.

5.2 Amendments to the Plan

The Department reserves the right to make modifications to this Plan. Substantial changes to this Plan may be subject to public review and comment.

5.3. Contacts

If you have questions on this plan please contact

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