

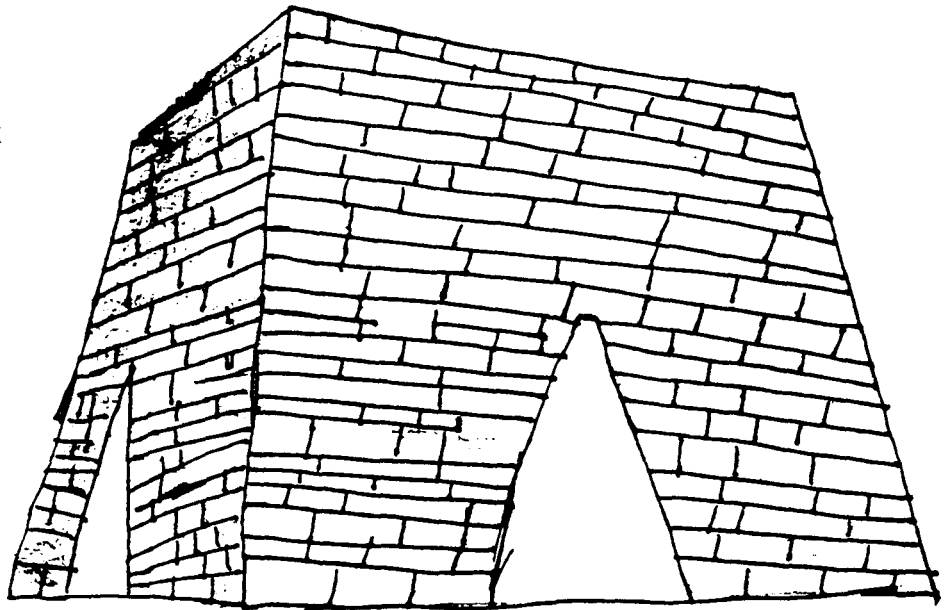
**HOPEWELL FURNACE NATIONAL HISTORIC SITE
WATER RESOURCE MANAGEMENT PLAN**

FINAL REPORT

William E. Sharpe
Professor of Forest Hydrology

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Graduate Assistant

**November 1993 National Park
Service Department of the
Interior**



PENNSSTATE



**ENVIRONMENTAL RESOURCES
RESEARCH INSTITUTE**

UNIVERSITY PARK, PA

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Hopewell Furnace National Historic Site

Water Resource Management Plan

Submitted: October 25, 1993

**Investigators: Dr. William E. Sharpe
Mr. William H. Neff**

**Prepared for: National Park Service
Department of Interior**

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1. INTRODUCTION

Nestled in a valley in southeastern Pennsylvania, near the headwaters of French Creek, rests Hopewell Furnace. The pastoral environment of the reconstructed iron furnace belies its past, as Hopewell was, from its construction in 1771 to its demise in 1883, a highly productive source of cast-iron goods and unrefined "pig" iron. Located at the border of Berks and Chester Counties, about fifty miles northwest of Philadelphia, Hopewell lies in the heart of a region that is steeped in early American history.

The U.S. Government acquired the land surrounding Hopewell Furnace in 1935, and a historic site was created there on August 3, 1938. The locale was selected for restoration and preservation because it serves as an excellent representative of the "iron plantations" which dotted the Pennsylvanian landscape during the eighteenth and nineteenth centuries. Regional availability of resources was a crucial consideration when choosing furnace locations during that era. Important resources included extensive stands of hardwoods for charcoal production, mineable outcrops of iron-rich rock, and substantial flowing water in the furnace's vicinity. Water was diverted from a stream channel or lake to the furnace's waterwheel, which powered "blast machinery" that fanned the flames within the furnace.

Supplies of water were not always adequate at Hopewell. Two headraces were used to divert water from three streams on the plantation grounds. The East Headrace captured water from Spout and Baptism Creeks, and the West Headrace drained water from the furnace pond, now overlain by Hopewell Lake. Water supplies were also utilized for domestic needs, livestock consumption, irrigation, and refrigeration, since the plantation was inhabited by a population of iron workers and their families. Perennial

springs located on a hillside near the furnace likely furnished cool drinking water that was a necessity in the sweltering confines of the ironworks.

Production at Hopewell Furnace was also facilitated by the presence of raw materials. Extensive shallow deposits of magnetite-rich rock were located nearby, providing easily accessed iron ore for the smelting process. The forestland in the area held large stands of chestnut and black oak, trees used in the production of charcoal. A constant quantity of charcoal was required to maintain sufficiently high furnace temperatures. The availability of these materials permitted the remarkable output of Hopewell Furnace during the height of its productivity.

Today, the Hopewell ironworks seem as if they are only momentarily abandoned, for the houses and workshops have been fully restored. Unfortunately, the park has also paid the price of time, and anthropogenic stress has begun to tax the quality of its natural resources. Water resources at Hopewell have been disturbed or threatened by a variety of activities. This plan has been developed to identify these activities and estimate the stress inflicted upon Hopewell's water resources. Potential monitoring and remediation options will also be discussed. The plan begins with a legislative and regulatory review, a discussion of land use activities, and a hydrologic evaluation of Hopewell's natural resources.

I.A. Purposes of the Water Resource Management Plan

The primary purposes of a water resource management plan are to document the condition of a specific hydrologic system in a coherent manner, and to recommend a program of action concerning the preservation and remediation of the components of that system. The plan will provide:

- 1) an examination of the existing water resources at Hopewell Furnace National Historic Site (HOFU), with emphasis placed on conditions warranting immediate concern or action,
- 2) a discussion of pertinent local, state, and federal government activities relating to HOFU,
- 3) an overview of current water-related projects at HOFU and adjacent French Creek State Park (FCSP),
- 4) a list of current and potential water resource problems at HOFU, prioritized in accordance with NPS management objectives, and
- 5) a series of possible remediative actions, presented according to their urgency and potential effectiveness.

I.B. Legislative and Planning Relationships

The following state and federal statutes have regulatory significance regarding Hopewell Furnace National Historic Site (HOFU) water resources. A description of the primary tenets of each statute is provided.

1.8.1 Federal Statutes

I.B.1.a. National Park Service Organic Act (1916)

The Organic Act specifies that the National Park Service (NPS) is responsible for the preservation and conservation of natural resources in all parklands under its jurisdiction. This act was reinforced by Congress in 1970 with legislation stating that all parklands are united by a common preservational purpose; regardless of title or designation. Hence, all water resources in the National Park System are protected equally by Federal Law, and it is a fundamental duty of the NPS to protect

those resources unless otherwise indicated by Congress.

I.B.1.b. National Historic Preservation Act (1966)

Since HOFU contains historical artifacts and structures, it must evaluate any project which places these resources at risk, as defined by Section 106 of this Act. The goal of the Act is to preserve historical resources for future generations.

I.B.1.c. Water Quality Act (1965)

The original legislation was amended significantly by the Water Quality Control Act Amendments of 1972, the Clean Water Act of 1977 and once again in 1987. This legislation's anti-degradation provisions provide a statutory cornerstone for the protection of water quality throughout the NPS system. At the same time the Act and subsequent amendments require that NPS managers comply with state implementing statutes for effluent limitations, federal development projects, wetland provisions (Sect. 404) and state established water quality criteria.

Any NPS facility that discharges pollutants is subject to state effluent permit requirements (NPDES). The NPS facility is treated under the law in the same manner as any private entity, and is subject to the same sanctions provided in the law to any entity.

All federal development projects, which would include construction projects in the NPS system, must be reviewed to insure compliance with state nonpoint pollution guidelines.

Section 404 of the Water Quality Control Act Amendments of 1972 covers the dredging and filling of wetlands. Again state laws apply and NPS managers must conform to the permitting requirements of the state. On the other hand, NPS

managers may comment on the issuance of 404 permits that could have potential adverse impacts on the park. This could lead to significant permit modifications of benefit to the water resources of the park.

State water quality criteria have been established for waters falling within a particular state's jurisdiction. These criteria and associated water uses are to be protected from degradation. All activities leading to either point or nonpoint pollution are regulated to maintain or enhance these criteria. Specific criteria for French Creek and its tributaries, portions of which flow through HOFU, are given later in this plan.

I.B.1.d. Safe Drinking Water Act (1974)

This Act protects the quality of water resources used for human consumption. Water supplies for public consumption and private use at HOFU are protected according to standards required by the Safe Drinking Water Act as delineated in NPS-83: Public Health Management Guidelines (NPS, 1991).

I.B.1.e. Fish and Wildlife Coordination Act (1934)

This Act stipulates that "whenever the waters of any stream or other body of water are proposed or authorized to be impounded, diverted, or otherwise controlled", the acting government body must consult first with the U.S. Fish and Wildlife Service, the Department of Interior, and the State agency responsible for overseeing management of wildlife which may be impacted.

I.B.1.f. Floodplain Management (Executive Order 11988)

The objective of this order is to require federal agencies to avoid, to the extent possible the long-term and short-term adverse impacts associated with occupancy and modifications of floodplains and to

avoid direct and indirect support of floodplain development wherever there is a practicable alternative.

I.B.1.g. Protection of Wetlands (Executive Order of 11990)

This order furthers purposes of the National Environmental Policy Act and the Clean Water Act by directing federal agencies to avoid, to the extent possible, the long-term and short-term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands when practicable alternatives exist.

I.B.1.h. National Environmental Policy Act (1969)

The National Environmental Policy Act (42 USC 4371 et seq.) requires that any major federal action which may significantly affect the human environment include review through the NEPA process. This is applicable to actions involving water resources, including changes to or increases in water use and treatment (i.e., constructing of sewage treatment plants, pipelines, residences, and visitor facilities). All actions proposed in this plan will be evaluated for compliance with NEPA at a level identified in each project statement.

1.8.2. State Statutes

I.B.2.a. Pennsylvania Clean Streams Law

In response to the Federal Clean Water Act, the Commonwealth adopted a system of water quality standards specified in Title 25 Ch. 93 of the Pennsylvania Clean Streams Laws. This system is organized in the manner preferred by the Environmental Protection Agency, the federal agency with authority to approve state water quality standards. The "use-specific" nature of the system provides standards for a specific reach of a stream according to the pre-

existing water quality and uses found in that reach. The highest designated use for French Creek is a cold water fishery. Standards listed for the stretch of French Creek between its source (Hopewell Lake) and the mouth of the South Branch, including all tributaries, are itemized in the Clean Streams Water Quality Criteria (Table 1). The Pennsylvania Department of Environmental Resources (PA-DER) enforces water quality standards with authorization from the Environmental Quality Board.

I.B.2.b. Pennsylvania Wild and Scenic Rivers Program (1972)

The Pennsylvania Wild and Scenic Rivers Program was created as a result of the Pennsylvania Scenic Rivers Act, which gives the Department of Environmental Resources full right and responsibility concerning the maintenance of the Pennsylvania Wild and Scenic Rivers System. Criteria listed in the Act which delineate the qualities necessary for scenic classification are:

- 1) Impoundments - Water shall be free-flowing within the reach.
- 2) Water Quality - Water quality should be capable of meeting minimum criteria for desired types of recreation except where exceeded by natural background conditions. Water must be capable of supporting the propagation of aquatic life, or must be in the process of restoration to that capability.
- 3) Development - Shorelines or water-sheds should be largely primitive. Man-made development, cultivation, timber harvest, and other resource uses are permitted, if accomplished without substantial adverse effects.
- 4) Accessibility - Water may be accessible by roads which occasionally bridge the river. Short stretches of conspicuous or

longer stretches of paralleling and inconspicuous roads or railroads may be permitted.

I.C. Land Use and Planning Relationships

Hopewell Furnace National Historic Site has an area of 848.06 contiguous acres, with no inholdings (Figure 1). It is divided between two townships, Union and Warwick, which lie within Berks and Chester Counties, Pennsylvania, respectively. Approximately two-thirds of HOFU is bordered by French Creek State Park, a park of primarily recreational value which receives substantial summer tourism. The remaining one-third is bordered by agricultural lands and low density residential development.

I.C.1. Land Use Adjacent to HOFU

The privately owned lands adjacent to HOFU are situated entirely within Warwick Township. In the late 70's, Warwick residents assumed an anticipatory stance regarding developmental pressures creeping into the township along its major byways. Consultation with a land use planning specialist resulted in a set of long-range goals for growth control in the township. These goals include the preservation of historic character, conservation of agricultural lands, protection of environmentally sensitive areas, and provision of orderly development. Although the lands south of HOFU are still at risk of piecemeal, high-density development, citizen activism has reduced the risk to a minimum.

French Creek State Park (FCSP) contains nearly all the French Creek Basin upstream of HOFU, and therefore is the source of much of the streamwater found in French Creek within NPS boundaries. Because of this relationship, the land use activities in the state park warrant as much attention as those occurring in HOFU itself. Since Hopewell Lake, the source of French Creek,

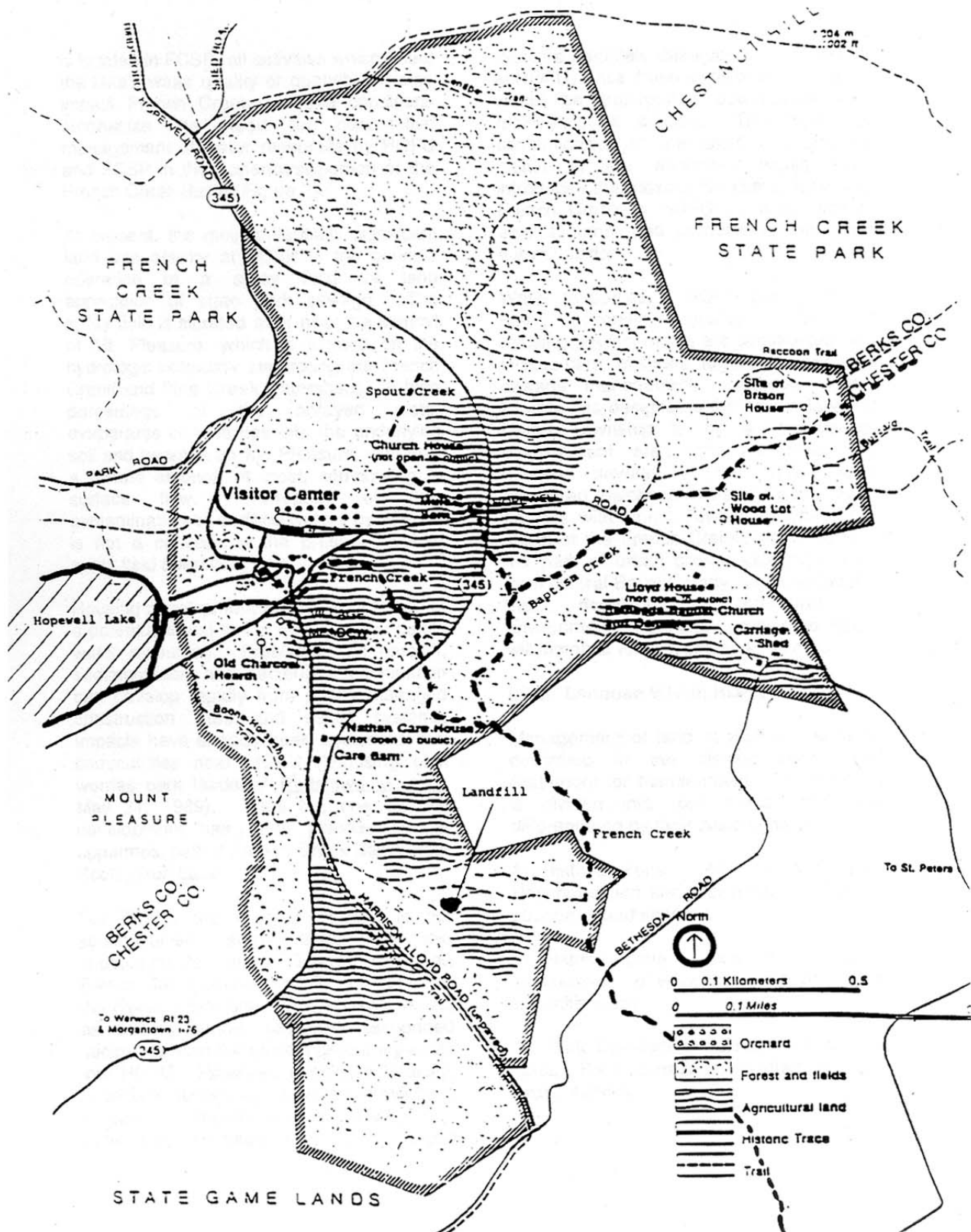
Table 1. Pennsylvania Water Quality Criteria for French Creek
(Source to South Branch)¹.

Specific Water Quality Criteria	Standards
Aluminum (Al)	Maximum 0.1 of the 96-hour LC50 for representative important species.
Alkalinity (Alk)	Minimum 20 mg/l as CaCO ₃ , except where natural conditions are less. Where discharges are to waters with 20 mg/l or less alkalinity, the discharge should not further reduce the alkalinity of the receiving waters.
Ammonia Nitrogen (Am)	The maximum shall not exceed the numerical value given by: un-ionized ammonia nitrogen (NH ₃ -N) x (log ⁻¹ [pKT - pH] + 1). The average over any 30 consecutive days shall be less than or equal to the numerical value given by: un-ionized ammonia nitrogen (NH ₃ -N) x (log ⁻¹ [pKT - pH] + 1).
Bacteria Bac	During the swimming season (May 1 - Sept. 30) the max. fecal coliform level shall be a geometric mean of 200 per 100 ml based on five consecutive samples each sample collected on different days; for the remainder of the year the maximum shall be a geometric mean of 2000 per 100 ml based on five consecutive samples on different days.
Fluoride (F1 and F2)	Daily average 2.0 mg/l. Four-day average 0.01 of the 96 hour LC50; one-hour average 0.05 of the 96 hour LC50 for representative important species.
	Daily average 1.5 mg/l as total iron; maximum 0.3 mg/l as dissolved iron.
Iron (Fe)	Maximum 1.0 mg/l.
	Maximum 10 mg/l as nitrogen.
Manganese (Mn) Nitrite	Maximum 50 milliosmoles per Kg.
+ Nitrate (N) Osmotic	From 6.0 to 9.0 inclusive.
Pressure (OP)	
pH (pH 1)	Maximum 0.005 mg/l, or four-day average 0.02 mg/l; 1-hour average 0.1 mg/l.
Phenolics (Phen1 or Phen3)	500 mg/l as a monthly average value; maximum 750 mg/l.

¹ Source: Commonwealth of Pennsylvania, Pennsylvania Code, Title 25. Environmental Resources, Chapter 93. Water Quality Standards, Current through 23 Pa. B. 2102 (April 24, 1993). Department of Environmental Resources, Bureau of Water Quality Management, Harrisburg, Pa. 17101-2301.

This map illustrates the layout of French Creek State Park and its surroundings. Key features include:

- Visitor Center:** Located near the intersection of Park Road and the main road, marked with a cluster of dots.
- Trails:** Several trails are shown, including the Raccoon Trail, the Site of Brison House, the Site of Wood Lot House, and the French Creek Trail.
- Landmarks:** Hopevell Lake is situated to the west of the park. The Visitor Center is near the intersection of Park Road and the main road.
- Historic Sites:** The map identifies several historic locations, including the Site of Brison House, the Site of Wood Lot House, the Lloyd House (not open to public), the Church House (not open to public), the Nathan Care House (not open to public), and the Care Barn.
- Geographical Features:** French Creek, Spout Creek, and Baptista Creek are shown flowing through the park. The map also indicates the location of the Visitor Center, the Site of Brison House, the Site of Wood Lot House, the Lloyd House (not open to public), the Church House (not open to public), the Nathan Care House (not open to public), and the Care Barn.
- Surrounding Areas:** The map shows the park's proximity to French Creek State Park, Berks Co., Chester Co., and State Game Lands.
- Legend:** A legend in the bottom right corner defines the symbols used for Orchard, Forest and fields, Agricultural land, Historic Traces, and Trails.
- Scale:** A scale bar indicates distances in both kilometers (0 to 0.5) and miles (0 to 0.1).
- Orientation:** A north arrow points towards the top of the map.
- Directions:** Arrows indicate directions to various locations, including "To St. Peters" and "To Warwick Rt 23 & Morgantown 1176".



is located in FCSP, all activities which affect the lake's water quality or quantity will also impact French Creek. These conditions emphasize the need for cooperative management of water resources by HOFU and FCSP in the uppermost portion of the French Creek Basin (Figure 2).

At present, the most potentially significant land use activity at FCSP is the periodic operation of a spray field for land application of state park sewage. The spray field is situated at or near the summit of Mt. Pleasure, which is located on the hydrologic boundary separating the French Creek and Pine Creek watersheds. A high percentage of the sprayed water evaporates or infiltrates into the underlying soil and bedrock on Mt. Pleasure, with only a minute amount, at most, contributing to surface flow. Because of this, contamination of surface waters by effluent is not a concern at the present level of spray field operation.

Housing development upstream of HOFU is a potential threat to the quality of the park's water resources. Problems with erosion, sedimentation, and bacterial contamination can develop rapidly from poorly managed construction sites and septic systems. Impacts have already been documented in communities near HOFU ("Housing plan worries park leaders," Pottstown Mercury, May 31, 1989). Thus far, one 43 unit development has been planned in the uppermost part of French Creek Basin, near Scott's Run Lake.

For HOFU, the greatest hazard is not sedimentation, since there are two impoundments along Scott's Run and French Creek between NPS parklands and the development site. These lakes will act as settling ponds, removing suspended sediments from the stream before it passes into HOFU. However, excessive turbidity, especially during high flows could still be a problem. Contamination by sewage and detergents released from leaky septic

systems definitely deserves close attention at HOFU, since those types of contaminants would be transported downstream with relatively little dilution. The impact of contaminants on the lakes and streams higher in the watershed would likely introduce other destructive components into French Creek in HOFU, such as scums, algal blooms, and products of increased eutrophication.

Water resources in HOFU are at risk of being severely degraded if up-basin housing developments are constructed with laissez-faire attitudes toward erosion and sewage management. Although Berks County has designated the private lands of Union Township to be a low density development area into the twenty-first century, several of the most highly urbanized townships in Berks County share borders with Union Township. The upper reach of the French Creek watershed is in the path of urban growth extending south from central Berks County, so it is inevitable that developmental pressures in environmentally sensitive areas near HOFU will increase for the foreseeable future.

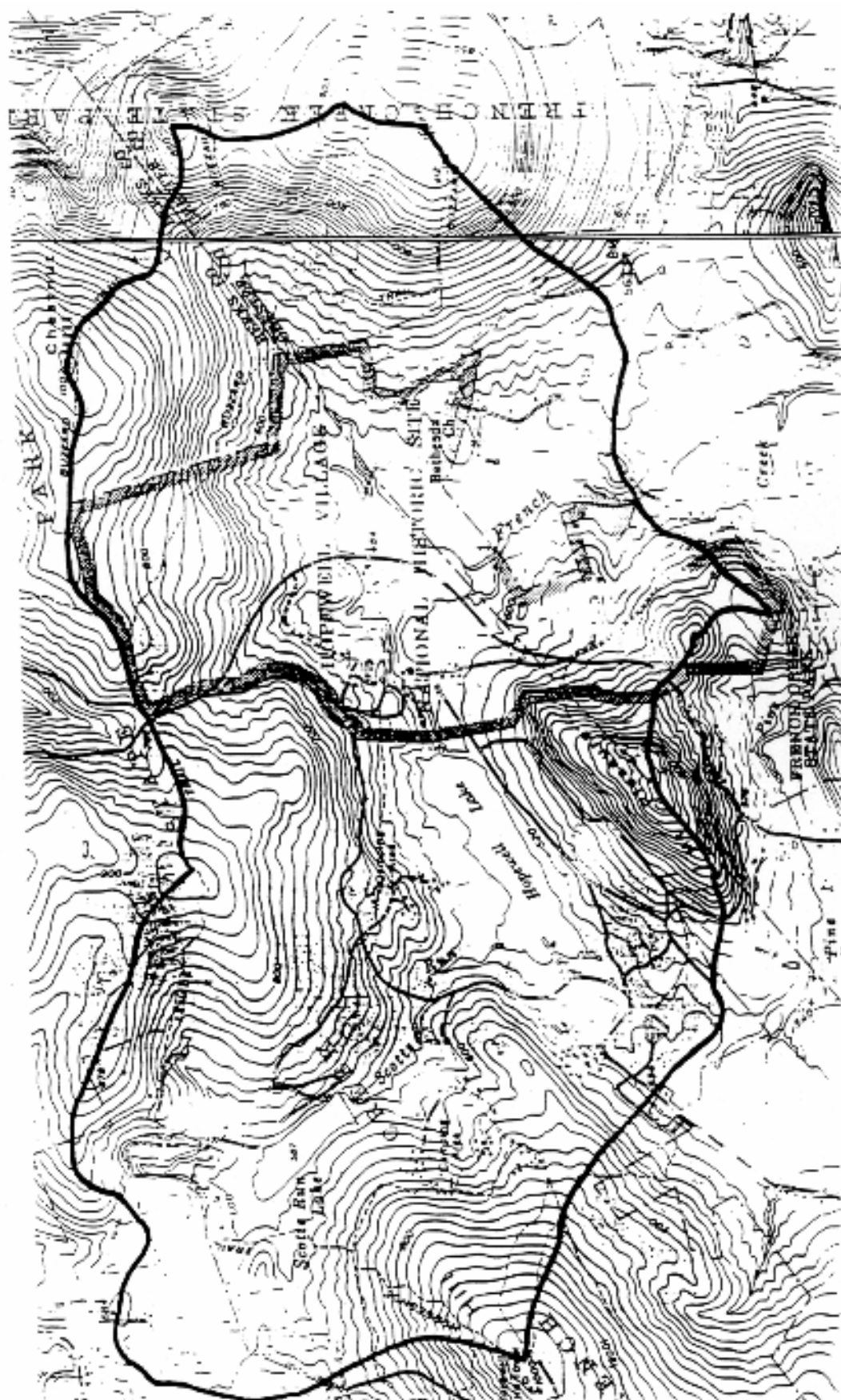
I.C.2. Landuse Within HOFU

Management of land at HOFU is explicitly described in the historic site's 1987 Statement for Management. The parkland is divided into four zones which are differentiated by their designated uses.

- 1) Historic Zone - 40% of park area. Reconstruction and preservation of historic structures and scenery.
- 2) Natural Zone - 55% of park area. Conservation of woodlands, recreation, and scientific study.
- 3) Park Development Zone - 4% of park area. Park operations, maintenance, and visitor service.

FIGURE 2

Hydrologic Boundaries for the Upper French Creek Watershed
(From U.S.G.S. Elverson and Pottstown Quadrangles)



4) Special Use - 1% of park area. Agricultural lands for preserving historic scenery, power line corridor.

The zones most likely to be reconfigured in the near future are the historic and natural zones.

Forested lands are much more extensive presently than during the period of industrial activity, when most of the land surrounding the furnace proper was logged and cultivated. Returning the forestland to agricultural use may affect the surface water quality in French Creek, primarily because of increased erosion. Most forms of agriculture tend to reduce infiltration and increase runoff, primarily because of reduced permeability at the soil surface. If organic or chemical fertilizers are used, degradation products of those substances will undoubtedly be introduced into surface waters of the park. Intensified agricultural activity at HOFU will require more sustainable methods of cultivation to avoid water resource degradation.

Two issues concerning pre-existing land use conditions at HOFU can be raised as well. Cattle and sheep which graze on HOFU lands have access to French Creek, and runoff from the stockyard drains into the waterwheel tailrace, which in turn empties into French Creek. A recent cursory water analysis found high concentrations of fecal streptococcus and coliform bacteria in French Creek. Risks involving dissolved oxygen depletion, increased eutrophication, and excessive turbidity also remain. However, these problems are not serious enough to warrant compromising the historical integrity of HOFU by corrective action.

High bacteria concentrations were also found in a sample from the mouth of Spout Creek. This measurement cannot be directly attributed to any kind of anthropogenic activity in the Spout Creek portion of the basin. Apparently the

meadows upgradient of the stream channel are heavily grazed by deer herds. Since prodigious amounts of deer excrement can cause bacterial contamination in nearby streams, a connection may exist between the deer habitat and surface water degradation in Spout Creek.

The NPS and the Civilian Conservation Corps created at least one landfill of unknown content near the southern boundary of HOFU. Its approximate location is known (Figure 1), but the impact of this dump on nearby groundwater and surface water has never been studied.

I.C.3. Man-made Hydrologic Structures Within HOFU

Presently, the west headrace, waterwheel, east headrace and tailrace are the only man-made hydrologic structures within HOFU. The park has submitted a proposal concerning reconstruction of Hopewell Furnace's East Headrace. Renovation of the canal to operational capacity would definitely increase the historical accuracy of HOFU's appearance. Currently the plans are being considered, and if funds are allocated for the headrace, the structure shall be excavated. Eventually water will once again flow along this impressive example of colonial engineering.

I.C.4. Water Resource Management Objectives

With mandate from the Historic Sites Act of 1935, an Executive Order (3FR 2039) was given which transferred several hundred acres of land in Berks and Chester counties to the Federal Government, thereby establishing the heart of what is now Hopewell Furnace National Historic Site (HOFU). The intention of this order was "to preserve for public use historic sites, buildings and objects of national significance for the inspiration and benefit of the people of the United States."

The draft Statement for Management for Hopewell Furnace includes the following objectives:

1. To preserve and protect artifacts, documents, historic objects, man-made structures and landscape features significant to the ironmaking operation and the Hopewell Community.

a) Preserve the rural landscape around the park to reflect the historic setting of the furnace community.

b) Preserve the rural approach to the part to place the Hopewell Furnace story in a rural context for the visitor.

c) Preserve and protect significant resources related to the ironmaking community.

d) Present a more complete representation of Hopewell Furnace's rural-industrial landscape of the 19th century through interpretation and resource management.

2. To provide all visitors with an understanding of Hopewell Furnace's historical significance.

a) Show how Hopewell Furnace exemplifies the state of the ironmaking industry in the early and developing United States.

b) Illustrate that the 112 years of Hopewell's operational and business history are a microcosm of the social, political, economic, and technological development in America during that period.

3. To actively cooperate and participate with other government agencies, park supporters, and private interests in planning for management, protection and use of resources which affect the scenic, natural, and cultural values related to the park.

4. To promote the use of the site's resources for research relating to park themes.

a) Disseminate the research undertaken and utilize scientific expertise and scholarship in the management process.

b) Promote the knowledge gained from research and study through publication and other media in the interest of public and professional support.

c) Develop a strong education outreach program.

5. To permit recreation and other activities that contribute to meeting park management objectives, and that are compatible and consistent with the park mission; and to maintain recreational facilities allowing visitors to experience Hopewell's resources outside the core village.

6. To manage natural resources to support cultural values while protecting and preserving natural resources in accordance with legislation and policy; and to provide leadership in the conservation of natural resources contributing to park values.

These objectives are all similar in that they require the preservation of the historic site in keeping with conditions present during peak historical activity.

In order to provide the highest quality experience for visitors at HOFU, a balance must be sought with regard to historical and ecological preservation. Present conditions in the HOFU parklands are quite different from those prevalent in the mid-nineteenth century. Impacts caused by the colonial inhabitants and rudimentary industrial processes were undoubtedly significant. In the twentieth century, a new set of environmental stresses has evolved. Effort must be made to promote a park

experience which is historically accurate, but water quality standards must also be maintained.

Restoration of the ironwork's water supply system has progressed since the park's inception, and more reconstruction is expected in the future. Restoration fulfills one of the most important objectives of this historic site. Nevertheless, proposed restoration activities must be consistent with current water quality regulations.

Specific water resource management objectives for the Hopewell Furnace are:

- To protect the natural processes of the water cycle from disturbance and thus preserve the diverse ecological systems dependent on natural water levels, flows and quality.
- To maintain or restore the quality of water resources through resource management actions and through cooperation with local communities and regional, state and federal agencies.
- To contribute to the scientific base for water resources management and perform and/or coordinate water resources research.
- To promote public awareness of the water resources of Hopewell Furnace NHS and an understanding of current and potential human impacts upon these resources.
- To promote water conservation through direct NPS action and through cooperation with local communities and regional, state and federal agencies.
- To provide for visitor safety by evaluating the quality of the water resources at Hopewell Furnace NHS and insuring that appropriate health based standards are met.

I.C.5. Water Resource Issues at HOFU

The issues listed below are prioritized in accordance with NPS management objectives. Associated project statements are identified after each issue. It is important to note that other significant issues may exist, and could be substantiated by a consistent water monitoring program. However, the content of this plan provides a good starting point for water resource evaluation in the park, and outlines the hydrologic relationships which are critical to the future health of all components of the hydrologic system in HOFU. More than one of these issues may be encompassed in a project statement.

- 1) **Sufficient water levels to maintain flow in the historic headraces and waterwheel.** Consistent water supplies must be available for operation of historical furnace structures.
- 2) **Stream contamination caused by up-basin development.** The planned French Creek Wood development may threaten water quality at HOFU.
- 3) **High suspended iron concentrations in French Creek.** Suspended iron is probably being produced by the **drawdown** of Hopewell Lake, and may chemically and visually compromise water quality.
- 4) **Decreased infiltration and surface water contamination caused by deforestation. Alterations in land use** could result in permanent changes in the hydrologic processes and water chemistry at HOFU.
- 5) **Best management practices for livestock.** High bacteria concentrations measured in French Creek and Spout Creek suggest livestock-related water quality impacts.

6) **Potential degradation related to acid precipitation.** Mobilization of metal ions and depressed pH are two documented surface water quality effects of acidified rain and snowfall.

7) **Exportation of water from French Creek Basin.** Increased FCSP spray field operations could cause quantitative problems at HOFU.

8) **Infiltrative loss of streamwater resulting from excessive municipal or private groundwater utilization.** Several watersheds in southeastern PA have already been impacted by deepening water tables.

9) **Seepage from landfill with HOFU.** Substances leached from landfill debris may contaminate surface water or groundwater.

10) **Wellhead protection.** All groundwater wells located within HOFU must be adequately grouted or sealed to prevent aquifer contamination.

11) **Wetlands survey and classification.** All wetlands areas within HOFU should be delineated and properly protected.

12) **East Headrace Water Diversion.** The flow reductions in Spout and Baptism Creeks attendant to reconstruction of the East Headrace should be evaluated.

II. THE HYDROLOGIC ENVIRONMENT

II.A. Physiographic Description

The headwaters of the French Creek watershed flow from springs in the Piedmont hills of southeastern Pennsylvania. Prominent topographic highs in the HOFU vicinity include Williams Hill, Brush Hill, Chestnut Hill, and Mt. Pleasure. These hills rise approximately 800-1000 feet above mean sea level, and 400 feet above French Creek as it flows through the core historic district (Figure 2).

Scott's Run Lake rests high in the watershed, and is replenished by small streams which are entirely spring-fed. Scott's Run issues from the lower end of the lake, flowing into the major impoundment of the basin, Hopewell Lake, several hundred yards downgradient. This lake captures a very high percentage of the water that will eventually flow into HOFU, and is the source of French Creek. The creek exits Hopewell Lake via a spillway and enters HOFU historic zone about 100 yards southeast. Water is also diverted from Hopewell Lake through a headrace which flows over a waterwheel in the central furnace works. Two more perennial streams enter French Creek in HOFU. Spout and Baptism Creeks are both spring-fed, and have relatively low discharges. Areas of poorly drained, seepy land along the banks of French Creek to the southeast of the historic zone constitute wetlands within HOFU. Several small, unnamed, spring-fed streams drain these wetlands, and enter French Creek in the woodlands near the southern boundary of the park.

The two parks located at the head of the French Creek watershed allow much of the basin to remain forested, in contrast to lands outside the parks which are developed for agricultural, residential and commercial uses. Percentages for various designated land uses in HOFU are found in the land use overview (p.10). French Creek State Park surrounds HOFU on three sides with forestland, and to the south, HOFU is bounded by small-scale agriculture, low-density residential development, and state game lands.

II.B. Climate

French Creek Basin has a climate typical of Mid-Atlantic lowlands, with warm humid summers and winters which are usually wet and mild. Mean summer temperature is 73 deg. F, while mean winter temperature is about 32 deg. F. Mean annual precipitation

is 42-44 inches, with approximately 25 inches falling during the frost-free season, a time period which averages about 188 days per year (PaDER, 1984).

11.C. Geology and Soils

Most of the parkland at HOFU is situated on the border of extensive Triassic Basic "redbeds," which are composed of sandstones and conglomerates. These rocks were deposited during a long period of erosional activity, when large quantities of sediments were produced, transported into lowland basins, and lithified. The resultant sedimentary rocks, known as the Hammer Creek and Stockton Formations, contain significant volumes of stored water, and are considered to be previous sources of high quality groundwater in southeastern Pennsylvania.

The southern portion of HOFU rests on a faulted complex of gneisses and diabase dikes. These rocks are associated with the Morgantown Pluton, a large body of molten rock that was emplaced and cooled at a depth of several thousand feet. Subsequent periods of intense erosion have excavated overlying rocks and sediments, exposing the igneous rock and related metamorphics. Magnetite-rich rocks deposited in association with the pluton provided iron ore for the operation of Hopewell Furnace. Very little groundwater is found in these rocks however, and they are not worthy of consideration in terms of water supply issues (Rima et al. 1962).

At least seventeen different soil types have been identified with the HOFU boundaries (U.S.D.A. Soil Conservation Service, 1967). All the soils are listed in order of prevalence, and the most common types are briefly described.

Lewisberry Series - Deep, well-drained, very stoney, sandy loam; typical in forested areas.

Bowmansville Series - Poorly drained silt loam formed in alluvial sediments; often utilized for pasture.

Klinesville Series - Shallow, well-drained, shaly silt loam; erosion hazard limits farm use.

Croton Series - Deep, poorly drained silt loams; found in nearly level areas, depressions, and drainageways.

Penn Series - Moderately deep, well-drained, shaly silt loam; moderate erosion hazard.

Lamington Series - Deep, poorly-drained, reddish silt loam; commonly located on stream channel terraces, fragipan subsoil.

Others - Readington Series, Glenville Series, Chester Series, Edgemont and DeKalb Series, Glenville Series, and "made" (excavated or disturbed) lands.

II.D. Surface Water Resources

II.D.1 Primary Drainages

French Creek, the primary flowing surface water in HOFU, is a tributary of the Schuylkill River. It reaches 21.9 miles southeast from headwaters to mouth, and drains a surface area of 70.2 square miles. In the proximity of HOFU, French Creek has relatively shallow banks, and is enclosed by moderately steep hillsides. Channel slope averages 20.7 ft./mile, and the stream maintains an irregular, dendritic drainage pattern in its upper reaches. French Creek shows little seasonal deviation in its hydrologic response to storm events, which is typical of rural watersheds. The degree of response is determined by the size of the precipitative event and the level of groundwater storage in the watershed prior to precipitation.

French Creek receives significant quantities of flow from two creeks within HOFU (Figure

1). Spout Creek, a spring-fed stream three-quarters of a mile in length, flows southeast from hills above the HOFU historic zone. Stream channel width increases from two feet to four feet along its reach, and the entire stream is densely shaded. Water flows at a moderate velocity over a rocky stream bed, where small pools and shelters are common. Flows in Spout Creek are moderately affected by dry weather periods.

Baptism Creek is a tributary of French Creek, and is approximately two and a half miles in length. It is fed by springs, and also by Spout Creek at a confluence just southeast of the intersection of Hopewell Road and Route 345. The stream is characteristically similar to Spout Creek, with a slightly larger and deeper stream channel, and marginally greater flow. Baptism Creek flows into HOFU from an east-northeasterly direction, crosses the eastern half of the park, and empties into French Creek near the Chester County line in the southern portion of HOFU.

II.D.2. Impoundments

Two impoundments are positioned between the upper limits of French Creek watershed and the upstream boundary of HOFU, both resulting from constructed earthen dams. The smaller of the two is Scott's Run Lake; the larger is Hopewell Lake (Figure 2). Both of these dams are within French Creek State Park and are owned by the Commonwealth of Pennsylvania. Both dams were inspected as required by the Federal Dam Safety Act. As a result of this inspection the Hopewell Lake Dam has undergone a recently completed emergency spillway reconstruction. This places both dams in compliance with this act.

Hopewell Lake is the primary source of water for French Creek within HOFU, hence it deserves attention when evaluating surface water resources within the park. The lake is located wholly within FCSP, although its outflow is less than 100 feet

from the western border of HOFU. Surface area draining into Hopewell Lake is 2.7 square miles in extent, and the outflow of Scott's Run Lake, known as Scott's Run, is the primary feeder stream, flowing in from the northwest. Diffuse overland flow also occurs from Pine Swamp, located to the west. Hopewell Lake at normal level has a surface area of 68 acres, a volume of 537 acre-feet, a shoreline length of 2.1 miles, and an altitude of 505 feet (above MSL). Its mean depth is 7.9 feet, maximum depth is 18 feet, and mean flow-through time is 89 days at 3 cubic feet/second (Characteristics of Recreational Lakes, 1978).

II.D.3. Water Quantity

Very little documentation exists for water quantity in the uppermost section of the French Creek Basin. Three measurements of flow at Hopewell Dam during the late summer of 1951 averaged about one cubic foot/second ("Pennsylvania Gazetteer of Streams," June, 1984). This is the only data available for the quantity of French Creek water at its source.

Various activities in FCSP pertaining to Hopewell Lake have led to five major drawdown events since the lake has been under state supervision. The effects of the drawdowns on the discharge from Hopewell Lake remain undocumented, although a lake water level drop of six feet or more will cut off water supply to the West Headrace, which feeds water to the waterwheel in the reconstructed furnaceworks. Reconstruction of the Hopewell Dam spillway by the Pennsylvania Department of Environmental Resources, concomitant with the assembly of this plan, has required a large lake level drawdown in 1992-93. The West Headrace was consequently cut off and HOFU has been forced to pump water to supply the headrace.

II.D.4. Water Quality

Physical data obtained from field measurements indicates that Hopewell Lake has good water quality and is thermally and chemically stratified for much of the year ("Characteristics of Recreational Lakes," April, 1978). A thermocline was well developed during July of 1973 and August of 1984, suggesting that such conditions are typical for Hopewell Lake. Both temperature and dissolved oxygen levels drop significantly beneath the upper thermocline. Dissolved oxygen is totally depleted below a depth of 13 feet. The lake water also becomes more acidic and increasingly laden with metallic constituents at depth. High trace concentrations of iron (100 micrograms/liter) can be attributed to the bedrock in the lakebed.

Under normal conditions, water chemistry at the outflow of Hopewell Lake will retain the characteristics of near-surface lakewater. Since Hopewell Lake is stratified for much of the year, this water will have an epilimnionic chemistry, which is low in dissolved solids and high in dissolved oxygen (PA Fish Commission, 1977). However, during drawdown conditions such as those that presently exist at Hopewell Lake, water is drawn from near the bottom of the lake. Discharge into French Creek will have the hypolimnionic chemistry of the deeper lake water, with higher acidity, higher dissolved solids, and less dissolved oxygen. This condition is qualitatively poor for the proliferation of aquatic biota in French Creek. Water chemistry at the lake outflow will be particularly poor if lake discharge is derived from the hypolimnion during early and mid-summer.

Detailed water quality data for French Creek in the vicinity of HOFU is virtually nonexistent. On August 14, 1986, samples of French Creek water at HOFU were collected and analyzed for fecal streptococcus and fecal coliform bacteria. One sample, from Spout Creek, contained

high bacterial concentrations. This measurement is discussed in the land use and planning section of this plan (p. 11).

Some isolated chemical data from water samples taken at a French Creek sampling station about one mile downstream from HOFU (USDI-GS Water Quality Data, April 10, 1992) were plotted against time with the purpose of discerning any obvious trends. Most fluctuations in the above French Creek stream water chemistry can be attributed to stochastic variability. Tributaries entering French Creek between its outflow from HOFU and the aforementioned downstream sampling station probably contributed chemical components to the tested streamwater as well. These conditions make substantive interpretations of the data impossible.

Iron staining found in 1992-93 on rocks at the outflow of Hopewell Dam suggests that an exceptional amount of dissolved and suspended iron is being transported downstream into French Creek from Hopewell Lake. Excessive turbidity and an orange discoloration is found in the water of Hopewell Lake and French Creek below the dam outflow, and is very apparent in the stream channel passing through the HOFU historic zone. This is a visual degradation of French Creek water, and is probably stressing the aquatic ecosystem as well. Extensive iron oxidation may result from the drawdown of lake water levels, and the consequential exposure of iron-rich sandstone bedrock to oxidizing conditions. Since these rocks are normally submerged in deep lakewater with lower dissolved oxygen concentrations, exposure to oxygen-rich waters near the surface, or to atmospheric conditions, will cause a massive increase in the oxidation of iron minerals. Concentrations of dissolved and suspended iron in French Creek stream water are presently unknown. However, the visual characteristics of water flowing through HOFU suggest that the effects of Hopewell Lake drawdowns are significant,

and there have already been five major drawdowns. The effects of repeated drawdowns of Hopewell Lake water level need to be examined, since ecological stresses of this sort can be very damaging to the aquatic biota of afflicted streams. Usually acidic precipitation has been documented at sites near HOFU. The mean annual pH of wet deposition in this area is about 4.2 (Lynch et al., 1990) It is most likely that this acidity is a result of anthropogenic influences on the atmosphere, in the form of industrial and automotive emissions. The impact of this phenomenon on aquatic ecosystems is not yet fully understood, but there is enough evidence to warrant serious concerns. All agencies responsible for the management of natural resources in southeastern PA should be aware of the deleterious ecological effects of acidified precipitation, and should be attentive to any indication that such conditions exist.

II.D.5. Floodplains

Site-specific floodplain delineation along French Creek within HOFU has not been undertaken. The PA-DER Division of Waterways uses a generic delineation which states that floodplains are "50 feet from the top of the banks" of major streams in the HOFU area. The PA-DER approximates 100-year floodplains using the USGS method of flood magnitude analysis, although no analysis has been performed on stream channels within HOFU. No permitting is required by the State of Pennsylvania for floodplain alterations within NPS park boundaries, although the NPS must follow regulations stated in Executive Order 11988 (Floodplain Management). This order stipulates that government agencies must consider all alternatives before undertaking any activity which might disturb floodplains under the agency's supervision.

II.E. Hydrogeology and Groundwater Resources

II.E.1. General Description

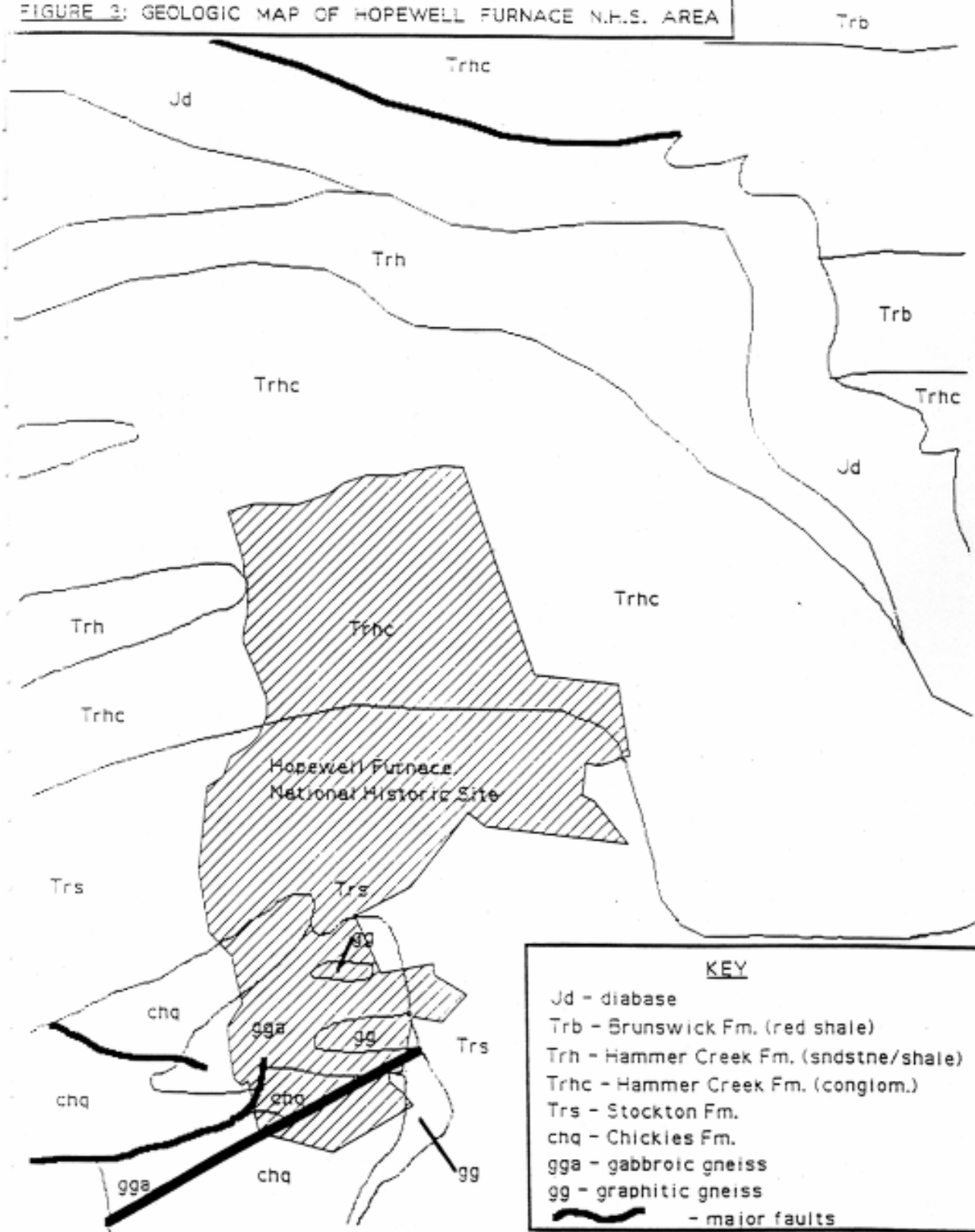
HOFU lies at the border of an uplifted Triassic Basin group and a heavily eroded plateau of metamorphic and igneous rocks, known as the Piedmont Upland (Figure 3). To the north and east, resistant beds of sedimentary rock have formed broad hills above the historic area, whereas the steeper slopes of Mt. Pleasure to the southeast are composed of faulted wedges of Piedmont gneiss and well-lithified quartzite. Softer sandstone emplaced between the gneiss and the resistant sediments has been preferentially eroded to form the floor of French Creek Valley.

The water table in the HOFU region is generally considered to be a subdued replica of surface topography (D. R. Rima et al., 1962). Springs are usually small, emitting from the lower flanks of hills. Water levels vary seasonally, with a decline beginning in March or April, and continuing until late autumn, when increased precipitation replenishes subsurface water storage.

II.E.2. Piedmont Upland

The fringe of the Piedmont Upland within HOFU is underlain predominantly by gabbroic and graphitic gneisses. These rocks commonly have very low storage capacity, although localized faulting of the rocks may increase groundwater storage and movement slightly (D. R. Rima et al., 1962). It has been noted that iron concentrations in water pumped from the gneisses increases with increasing depth of well placement. Deeper flow systems move less vigorously, so water has a prolonged exposure to the iron-rich metamorphic rock, intensifying mineralization.

FIGURE 3: GEOLOGIC MAP OF HOPEWELL FURNACE N.H.S. AREA



II.E.3. Triassic Basin Sediments

An unconformity separates the crystalline Piedmont from overlying Triassic sediments. Above it is the Stockton Formation, a series of interbedded conglomeratic sandstones, shales, and siltstones deposited as alluvial fans in the Triassic lowlands. This formation underlies and is recharged through the valley floor in the upper reaches of French Creek Basin. Bedding dips north-northwest in the HOFU region at angles of 5 to 25 degrees. The middle member of the Stockton, a moderately-sorted, poorly cemented, arkosic sandstone, typically has the best hydrologic qualities for well production. The water supply wells presently in use at HOFU were drilled in the Stockton Formation, and probably pump mainly from the middle member. Lateral changes in the texture and porosity of the sandstones and conglomerates cause site-specific variations in well yields.

In the vicinity of HOFU, the Stockton Formation is completely bounded by impermeable crystalline rocks, except down-dip to the north, where it is overlain by more Triassic sediments. The upper shale member probably acts as an aquitard beneath this contact, so interaquifer hydraulic connection is poor or nonexistent. These boundaries define an aquifer of relatively small size. With the present well water utilization in the area, it appears that there will be sufficient supplies for the foreseeable future and little likelihood of contamination. However, it should be noted that large increases in pumping may cause a significant drawdown of aquifer water levels and consequently induce recharge from Hopewell Lake and French Creek. Loss of surface water to groundwater storage may have negative effects on the hydrology of the watershed (D. R. Rima et al., 1962).

The Stockton Formation is conformably overlain by the Hammer Creek Formation, which is locally represented by a lobate

fanglomerate. This quartz-pebble conglomerate is very resistant to erosion, and forms the hills north and east of the park's historic zone. The formation has good storage capacity and yields groundwater which generally exceeds potability requirements. The dip of the Hammer Creek Formation precludes its utilization within HOFU park boundaries, since wells need to be placed down-dip, or north, of recharging outcrops, and the Hammer Creek outcrops in the northernmost portion of the park (C. R. Wood, 1980).

II.E.4. Diabase

Diabase rocks in the HOFU vicinity were emplaced prior to and during deposition of the Triassic sediments. These dikes and sills of impermeable igneous rock act as groundwater flow boundaries. Such boundaries impede groundwater flow, increasing residence time and concurrent mineralization.

A tentative but interesting correlation can be discerned when surface water concentrations of sulfate, chloride, and silica are compared over time. Temporal plots of these solutes (Appendices) indicate large fluctuations in concentrations between 1975-1977 and 1981-1982. The increased dissolved silica concentrations suggest a volumetric increase in groundwater baseflow as a fraction of total streamflow during these time periods. The fact that dissolved sulfate and chloride variations correlate with fluctuations in dissolved silica concentrations suggest two conditions. First, like most stream systems, French Creek stream chemistry is substantially altered when baseflow dominates total streamflow. Second, impermeable diabase formations in the area create stagnant groundwater zones in which sulfate and chloride concentrations are intensified.

II.E.5. Groundwater Supply

Two groundwater supply wells are presently in use at HOFU: a public supply well northwest of the HOFU maintenance building, and a private supply well located in the front lawn of the Lloyd House.

Data from the wells indicate that the well water is generally of good quality, although two components manganese (0.05 mg/l), and iron (0.3 mg/l) exceed USEPA and PA-DER drinking water standards (News Splash, 1993). Sodium, bicarbonate, sulfide, and chloride are also somewhat elevated in groundwater and springwater throughout the park, though not at levels which compromise quality. None of the levels reported for any water quality parameter constitute a threat to public health.

A pump test performed on HOFU Well BE-523 in 1966 indicated a specific capacity of 1.14 gallons per minute per foot for the well. This value indicates the well's relative "strength," or what rate of pumping can realistically be applied to the well. The maximum pumping rate suggested for the well was 25 gallons per minute for a period of eighteen hours, or higher rates for shorter periods. Most of the groundwater contribution in this well was derived from a section of the Stockton Formation at a depth of 75 to 85 feet. The water table was reached at a depth of 65.41 feet.

No other quantitative data are available for groundwater supplies at HOFU.

II.F. Aquatic Biota

French Creek supports a diverse aquatic ecosystem, indicating relatively high water quality. The creek has been stocked with rainbow and brown trout (*Oncorhynchus mykiss* and *Salmo trutta*) by the Pennsylvania Fish Commission as recently as 1976. Some long-time HOFU park employees are convinced that the stretch of

French Creek within HOFU harbors a population of brook trout (*Salvelinus fontinalis*). Two other creeks at HOFU were stocked with brook trout: Baptism Creek, once a year from 1949-1951, and Spout Creek, once a year from 1950-1951. Both streams empty into French Creek.

Many other varieties of fish thrive in the waters of French Creek. These include minnows (*Pimephales notatus/promelas*), daces (*Rhinichthys atratulus/cataractae*), pickerels (*Esox a. americanus/niger*), sunfishes (*Lepomis auritus/cyanellus/gibbosus*), shiners (*Notropis hudsonius/procne/spilopterus*), darters (*Etheostoma o/mstedii*), killifish (*Fundulus diaphanus*), and madtoms (*Noturus insignis*). Creek chub (*Semotilus atromaculatus*), white suckers (*Catostomus commersoni*), and fallfish (*Semotilus corporalis*) also live in HOFU stream water, as well as rock bass (*Ambloplites rupestris*), smallmouth, and largemouth bass (*Micropterus dolomieu*, *salmoides*).

A large variety of aquatic invertebrates provide a prey base for the numerous vertebrates in French Creek. These include the larvae of several types of flies, including mayflies (*Ephemeroptera*), caddisflies (*Trichoptera*), stoneflies (*P/ecopectera*) and dragonflies (*Odonata*). There are an abundance of beetles from the Dryopidae, Dytiscidae, Elmidae, Gyrinidae, and Psephenidae families. Other types of organisms found in the waters of French Creek at HOFU are water striders (*Hemiptera*), planaria (Planariidae), gastropods (*Gastropoda*), freshwater clams (*Pelecypoda*), and freshwater nymphs (*Polymictarcidae*) (PA Fish Commission, 1977).

No threatened or endangered biota are known to exist in the aquatic ecosystem at HOFU.

II.G. Consumptive and Non-consumptive Water Uses

The consumptive uses of water resources at HOFU are, at present, limited to groundwater wells utilized primarily for public consumption, surface water consumption by park livestock, and maintenance of ecosystems.

Both supply wells at HOFU utilize the Stockton Formation. The main public supply well is located approximately three-tenths of a mile from the HOFU maintenance building. A private supply well for HOFU staff is located in front of the Lloyd House.

The streams within the HOFU boundaries support a diverse and thriving ecosystem, which is inextricably linked to the quality and quantity of available water. Because of this relationship, ecological processes within the park comprise an important consumptive use as well.

The non-consumptive water use perceived as most important to park operation at HOFU is the water use to soak and turn the waterwheel of the furnaceworks. If the wheel is not kept wet, it may be severely damaged by consequent desiccation. Water is carried to the waterwheel from Hopewell Lake in normal conditions by the West Headrace. If the water level of the lake drops substantially, the headrace is cut off, and water must be channeled from other sources to keep the wheel turning. This has been a significant issue during past drawdowns of Hopewell Lake.

French Creek is assigned a cold water fishery classification in Pennsylvania Clean Streams Regulations (p. 6). Fishing is permitted in HOFU downstream of the Rt. 345 bridge.

The volume of water in French Creek is also important, for aesthetic reasons. The creek is part of the historical scenery at HOFU,

and to have stream water quality or quantity which radically deviates from seasonal norms could be considered degradation of the cultural landscape at HOFU.

II.H. Pennsylvania Water Rights Law

Legal aspects of water resources in Pennsylvania are based on common law precedents resulting from court cases over the last two centuries. Since common law is based on a series of specific court decisions rather than an established legal code, the development of state water law is an ongoing and continuous process.

The "riparian doctrine" defines water rights primarily by ownership of contiguous land adjacent to the water resource, and secondarily by the type of utilization. Since the Federal Government owns the land within HOFU, the NPS has rights to surface and subsurface water within the boundaries of HOFU. Practices such as excessive consumptive use of surface water or exportation of water over major hydrologic boundaries are actively discouraged by the Pennsylvania court system and the PA-DER. There is no indication that such activities will be necessary at HOFU, however, and guidelines presented in the HOFU Resource Management Plan (July 1988) suggest that no water rights issues will arise concerning the park's water utilization.

III. WATER RESOURCES MANAGEMENT PROGRAM

III.A. Water Resources Issues and Proposed Actions

Specific actions to address water resource issues are presented in this section. In each case where an action is proposed that will require an additional commitment of staff or funding, a project statement is included in Section III A. Water Resources Management Project Statements.

Project statements are the basic unit used to propose resource management actions in the National Park System. Each presents one significant issue with recommended actions for dealing with that issue. Possible alternative actions are included where appropriate, as well as the need for environmental or cultural compliance prior to implementing the proposed action. These project statements are considered part of the more comprehensive Resources Management Plan, and will be incorporated there for funding and programming purposes.

This is a dynamic plan that will be updated as new information becomes available and priorities change. Programming sheets and project statements will be updated regularly.

The following project statements are numbered according to their priority for execution from highest priority (lowest number) to lowest priority (highest number).

III.B. Developing A Water Resource Monitoring Program

Water resources monitoring can be implemented using one of several configurations, depending upon the intent of the monitoring program. Spatial and temporal resolutions can be adjusted to suit both the scientific and financial parameters of a monitoring project, yielding a database which satisfies the documentative needs of

HOFU without creating an unnecessary fiscal burden.

At present, water resource conditions and utilization at HOFU suggest that a site-specific monitoring program should be systematic, but highly repetitive sampling is not necessary. An intensive monitoring program conducted for three year period every ten years is suggested. Increased sampling over a given time will allow for interpretations of greater accuracy. If certain chemical components are found to have particular significance, intensified sampling and testing can be initiated for the specific components.

Following the identification of contemporary HOFU water resource issues, five sampling locations within the park boundary were chosen (Figure 4). Two sites are located at the intersections of French Creek and HOFU boundaries, both the initial inflow and final outflow. These locations were selected so that sampling will record the stream chemistry of French Creek as it enters and leaves the park. Two other sites are located at the intersection of Spout and Baptism Creeks and the remains of the East Tailrace. The samples taken at those locations will record stream chemistry entering French Creek from the tributary streams. The fifth site is positioned approximately fifty yards below the furnace stockyard. This site will record the French Creek stream chemistry near the center of HOFU, and will monitor the aquatic impact of the stockyard as well.

The resultant sampling procedure will yield data which can be used to evaluate ambient water quality conditions in a hydrologic system over time. Chemical components that will be monitored include pH, specific conductivity, nitrogen species, sulfates, lead, nickel, cadmium, iron, aluminum, and bacterial concentrations. Specific components are selected because of their relevance to present water issues at HOFU. The temporal emphasis of this program will

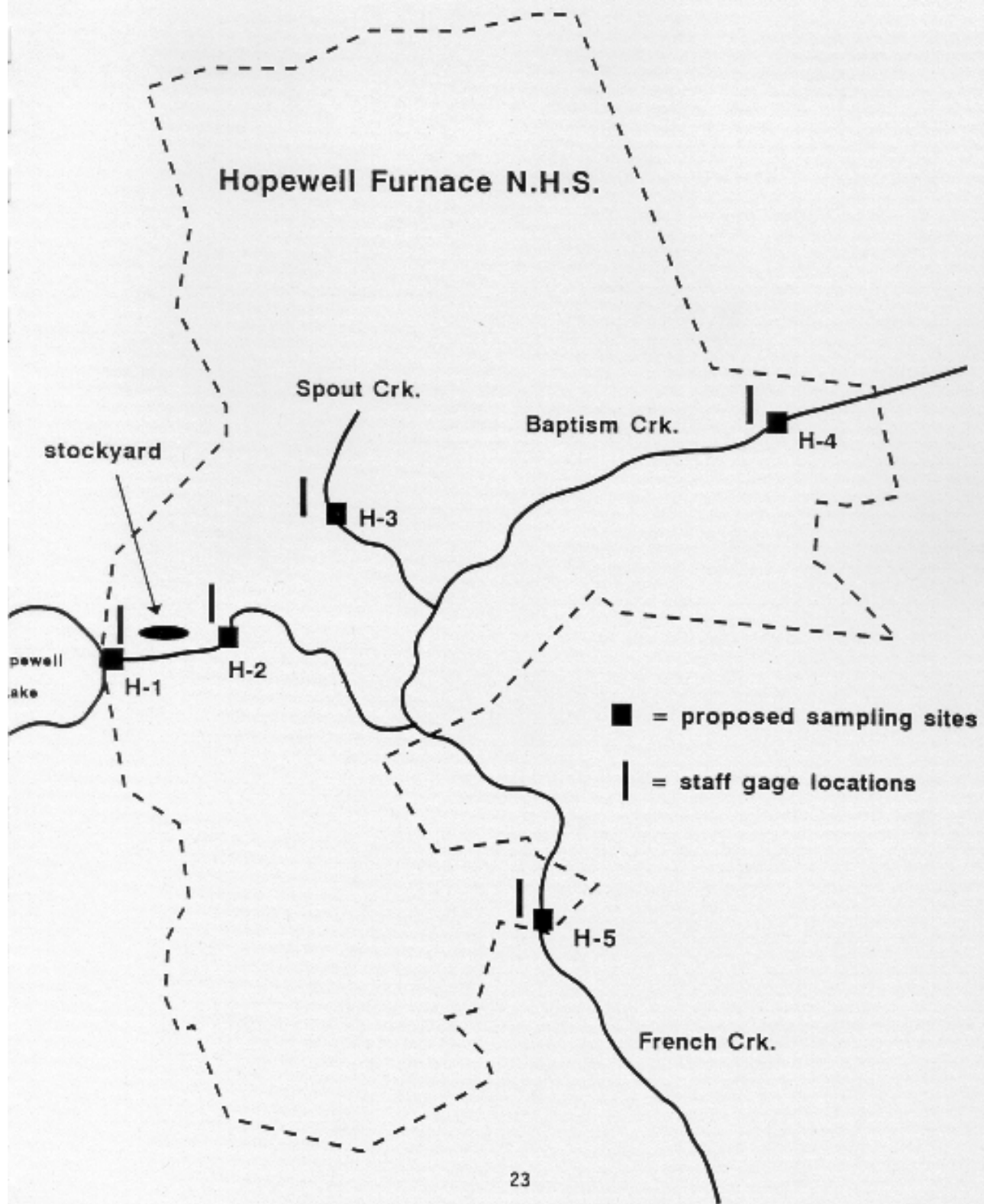
produce an evaluation of park water quality that documents any change in the prevailing chemical concentrations of HOFU surfacewaters.

For a complete documentation of hydrologic conditions, a study of the quantitative aspects of French Creek streamflow at HOFU is also recommended. Staff gauges at the inflow and outflow of French Creek (Figure 4), used in conjunction with a current meter, will allow the approximation of flow rates by developing a "rating curve." This curve is used, in conjunction with a staff gauge, to determine the instantaneous volume of discharge at a certain point along a stream channel. A database of this sort contains the essential information for calculation of basic hydrologic parameters, including low flow, high flow, groundwater contribution, and seepage, as well as for determination of the impacts of upstream water diversions and land use alterations.

Biological monitoring will involve implementation of the USEPA's Rapid Bioassessment Methodology (USEPA, 1989). Twice annual sampling (Spring and Fall) is suggested. This monitoring will be accomplished at all five sites for the three year intensive study period. The intent is to repeat these measurements for three year periods every ten years.

The reader is referred to Project Description HOFU-N-200 for additional details.

Figure 4: Streamwater sampling sites and staff gage locations for HOFU Monitoring Plan.



III.C. Water Resources Project Statements

NATURAL RESOURCE PROJECT STATEMENT

1. **HOFU-N-200**
2. **Memorandum of Agreement with French Creek State Park**
3. Systemwide Issue: N11, N12, N13
4. Problem Statement: French Creek State Park is operated by the Commonwealth of Pennsylvania and lies directly upstream of HOFU. Moreover, the water necessary to propel the water wheel at HOFU comes from an intake located in Hopewell within the state park. Regulation of water levels within the lake have a direct impact on the supply of water to HOFU. Also because French Creek State Park and HOFU essentially share on an intimate basis the same resource, it is highly advisable that they develop mutually compatible and complementary water resource management plans.
5. Optional section not included.
6. Description of Recommended Activity or Project: a memorandum of agreement should be prepared to issue coordination between French Creek State Park, and HOFU on the management of the common water resources of the upper French Creek Basin.
7. Compliance: None required
8. Relationships: This project relates to:
 - HOFU-N-200
 - HOFU-N-201
 - HOFU-N-202
 - HOFU-N-203
 - HOFU-N-204
 - HOFU-N-205
9. Funding:No additional funds should be required.

NATURAL RESOURCE PROJECT STATEMENT

1. HOFU-N-201

2. Establish Baseline Water Quality and Quantity Data

3. Systemwide Issue: N20

4. Problem Statement: No database is available for analysis of future water quality and quantity trends at HOFU. It is not possible to anticipate potential water resources problems and plan to deal with them appropriately without adequate baseline data. The impact of proposed developments in the French Creek watershed, including a housing development and improvements at the adjoining French Creek State Park, cannot be adequately evaluated without baseline data. As a result of this study of the water resources at HOFU, it has been determined that baseline data characterizing the water quality and quantity of the water resources in HOFU are lacking.

5. Optional section not included

6. Description of the Recommended Activity or Project: A water quality monitoring program should be undertaken to provide baseline water quality data. This project should involve monitoring at five sites within the Park on a monthly basis for three years. In addition two storm samples should be collected each year. Monitoring sites would be located on French Creek at HOFU upstream and downstream boundaries and downstream of the stockyard. In addition monitoring stations would be established on Spout and Baptism Creeks at the intersections of these streams and the east headrace. Standard water quality parameters would be included in this analysis.

Permanent staff gages would be established at all water quality sampling points. These would be noted a sufficient number of times during the three years to establish a suitable flow rating curve.

7. Compliance: None required

8. Relationships:

9. Funding:

	Year		
	1	2	3
Personal Services	\$19,000	\$19,000	\$19,000
Others	\$25,000	\$25,000	\$25,000
Total	\$44,000	\$44,000	\$44,000
Funds Available in Park Base	0	0	0
Additional Funds Needed	\$44,000	\$44,000	\$44,000

NATURAL RESOURCE PROJECT STATEMENT

1. **HOFU-N-202**

2. **Assess Potential Ground Water Contamination from NPS/CCC Solid Waste Disposal Site**

3. Systemwide Issue: N06, N11

4. Problem Statement: A small solid waste disposal site exists near the downstream intersection of the HOFU boundary and French Creek. The site is in a natural ravine with an ephemeral stream flowing from the base of the ravine during wet weather. The ephemeral stream was sampled on two occasions as a part of this research project. No pollution was detected on either occasion. Nonetheless the contents of the disposal site are unknown, as are the potential groundwater impacts.
5. Optional section not included.

6. Description of the Recommended Activity or Project: A test well will be based immediately adjacent and down groundwater gradient from the dump site. Water samples will be collected from this test well to determine the presence or absence of pollution from the site. A full suite of heavy metals and an organics seam will be included in the analysis. Sampling will be sufficient in frequency to allow any seasonal differences to be enumerated.

7. Compliance: This project will determine whether or not HOFU is in violation of Pa. Clean Streams Law.
8. Relationship:

9. Funding:

	Year		
	1	2	3
Personal Services	\$25,000		
Others	\$18,000		
Total	\$43,000		
Funds available in Park Base	0		
Additional Funds Needed	\$43,000		

NATURAL RESOURCE PROJECT STATEMENT

1. **HOFU-N-203**

2. **Wetland Delineation**

3. Systemwide Issue: N06, N20, N12

4. Problem Statement: Although there are no requirements to delineate wetlands per se, any future projects that may impact wetlands will require such delineators. In addition, because of the interest in wetland protection, it would seem prudent to include a wetlands inventory as part of the basic resource inventory of HOFU. HOFU may be unknowingly impacting wetlands through routine activities.

5. Optional section not included.

6. Description of the Recommended Activity or Project: The HOFU Historic Site will be inventoried utilizing standard inventory techniques to determine the location and extent of wetlands existent within the HOFU boundary. This information will be incorporated into the HOFU RMP.

7. Compliance: None required.

8. Relationship:

9. Funding:

	Year		
	1	2	3
Personal Services	\$12,000		
Others	\$10,000		
Total	\$22,000		
Funds available in Park Base	0		
Additional Funds Needed	\$22,000		

NATURAL RESOURCE PROJECT STATEMENT

1. **HOFU-N-204**
2. **Water Supply Well Assessment**
3. Systemwide Issue: N20
4. Problem Statement: At least one nonpublic water supply well exists on the HOFU site. This well individually serves structures that are private residences for HOFU employees. A sanitary survey of this well should be conducted to insure that it is not vulnerable to surface contamination and to determine what if any construction deficiencies exist. Water quality analyses would also be appropriate to ascertain compliance with acceptable drinking water quality standards.
5. Optional section not included.
6. Description of the Recommended Activity or Project: This well should be inspected to determine whether or not it has been constructed to appropriate standards. Feasible corrective actions will be taken if standards are not met. Water analysis will be conducted to determine the safety of the water supply. If necessary, water treatment recommendations will be made.
7. Compliance: None required
8. Relationship:
9. Funding:

	Year		
	1	2	3
Personal Services			
Others			\$2,000
Total			\$3,000
Funds available in Park Base			\$5,000
Additional Funds Needed			0
			\$5,000

NATURAL RESOURCE PROJECT STATEMENT

1. **HOFU-N-205**

2. **Water Conservation**

3. Systemwide Issue: N24

4. Problem Statement: One of the objectives of the NPS is to educate the general public and serve as good example of resource stewardship. In the case of HOFU this is especially important because the wastewater disposal system at HOFU is contained on-site.

Conservation would reduce the hydraulic load to the wastewater disposal system. Energy savings would also be realized from reduced hot water use.

5. Optional section not included

6. Description of the Recommended Activity or Project: An evaluation of domestic water use at HOFU will be conducted. Where appropriate, measures to conserve water will be suggested. These will include installation of state-of-the-art water conserving plumbing fixtures in staff and public restroom facilities. Where possible these will be equipped with educational information to demonstrate to the general public the potential for water conservation in their own houses.

Compliance: None required

7. Compliance: None Required

8. Relationship:

9. Funding:

	Year		
	1	2	3
Personal Services	\$4,500		
Others	\$18,000		
Total	\$22,500		
Funds available in Park Base	0		
Additional Funds Needed	\$22,500		

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V. CONSULTATION AND COORDINATION

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VI. APPENDICES

APPENDIX A. List of Preparers

The Pennsylvania State University

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Hopewell Furnace National Historic Site

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APPENDIX B. Water Quality for French Creek at Trythall, Pa. 1971-1982 (USGS 1992)

Year	Parameter						
	T (OC)	SPC (umhos)	pH	DO	Fe ------(mg/l)	SO4 -----	CL
1971	16.0	70	7.5		-	18.0	3.2
1972	14.0	55	6.9	-		6.0	1.5
1973	17.5	81	6.3	-	.18	6.5	2.7
1974	11.0	45	8.4	-	.18	6.7	2.3
1975	13.0	60	7.1	9.2	.19	7.1	2.7
1976	7.0	101	7.0	11.4	.22	15.0	4.8
1977	13.5	70	6.9	10.1	.24	7.6	1.7
1978		85	6.9	11.6	.29	6.5	4.2
1979	8.0	42	6.9	11.8		6.7	2.6
1980	7.0	85	7.1	10.6	.09	6.2	2.3
1981	9.0	75	7.0	10.1	.13	6.1	2.6
1982	10.0	75	6.4	9.9	.32	10.0	4.1

**APPENDIX C. Description of Sampling Sites for
1992-93 Surface Water Sampling
by Penn State Univ.**

All site locations are indicated on Figure 4.

<u>Site No.</u>	<u>Description</u>
H-1	25 meters downstream old spillway at Hopewell Lake at HOFU boundary
H-2	20 meters downstream of tailrace and French Creek confluence
H-3	Spout Run at crossing point of East Headhouse
H-4	Baptism Creek at intersection point with East Headhouse
H-5	Intersection of downstream HOFU boundary and French Creek
H-6	Intermittent stream directly below ccc dump site

**APPENDIX D. Inorganic and Biological Water Quality Data Summary for PSU Project
HOFU, Low Flow Sample 11-18-92.**

Parameter	Location					
	H-1	H-2	H-3	H-4	H-5	H-6
pH	6.95	6.99	7.13	6.94	7.15	6.37
SPC (umhos/cm)	77.0	85.8	61.5	31.3	83.6	107.2
NO3-N (mg/l)	0.17	0.23	0.10	0.01	0.31	1.6
Turbidity (FTU)	8.2	6.2	1.0	0.6	3.4	2.5
SO4 (mg/l)	14.9	15.1	9.1	4.3	12.1	17.1
Cl (mg/l)	5.7	5.1	4.4	1.6	4.7	3.0
Pb (mg/l)	ND ¹	ND	ND	ND	ND	ND
Ni (mg/l)	ND	ND	ND	ND	ND	ND
Cd (mg/l)	0.0004	0.0003	0.0003	0.0003	ND	ND
Fe (mg/l)	0.12	0.08	0.01	0.02	0.08	0.01
Al (mg/l)	0.01	0.01	0.02	0.04	0.06	0.05
Total Coliform bacteria (noJ100ml)	20	10	32	25	15	NS ²
Fecal coliform bacteria (noJ100ml)	64	86	10	3	82	NS
Fecal Streptococcus 122 bacteria (noJ100ml)		107	22	6	23	NS

¹ ND- none detectable

² NS- no sample

**APPENDIX E. Inorganic and Biological Water Quality Data Summary for PSU Project
HOFU, High Flow Sample 3-23-93.**

Parameter	Location					
	H-1	H-2	H-3	H-4	H-5	H-6
pH	6.99	6.92	6.77	6.80	7.00	6.79
SPC (umhos/cm)	56.4	62.1	69.4	28.3	64.8	70.2
NO3-N (mgA)	0.09	0.14	0.09	0.02	0.15	0.43
Turb (FTU)	1.7	2.8	1.7	0.7	1.8	3.6
SO4 (mg/l)	8.4	9.2	9.9	5.3	9.4	15.2
Cl (mg/l)	2.2	2.3	7.6	1.4	4.2	1.2
Pb (mg/l)	ND ¹	0.001	0.002	ND	0.001	ND
Ni (mg/l)	ND	ND	ND	0.001	ND	ND
Cd (mg/l)	0.0006	ND	ND	ND	ND	ND
Fe (mg/l)	0.015	0.026	0.029	0.014	0.036	0.062
Al (mg/l)	0.013	0.018	0.016	0.044	0.041	0.006
Total coliform bacteria (noJ100ml)	ND	4	48	11	169	NS ²
Fecal coliform bacteria (noJ100ml)	ND	15	21	2	58	NS
Fecal streptococcus bacteria (noJ100ml)	ND	ND	4	ND	5	NS

ND-none detectable ²

NS-no sample

**APPENDIX F. Low Flow Organic Water Quality Data Summary for Point H-6 for PSU
Project HOFU sample 11-18-92.**

<u>Parameter</u>	<u>Concentration</u>	<u>Detection Limit</u>
	(ug/l) <5	(ug/l)
Benzene	<5	5
Biomodichloromethane	<5	5
Biomofom	<10	5
Biomomethane	<5	10
Carbon tetrachloride	<5	5
Chlorobenzene	<10	5
Chloroethane	<5	10
2- Chloroethylvinyl ether	<5	5
Chloroform	<10	5
Chloromethane	<5	10
Dibromochloromethane	<5	5
1,2- Dichlorobenzene	<5	5
1,3- Dichlorobenzene	<5	5
1,4- Dichlorobenzene	<5	5
1,1- Dichloroethane	<5	5
1,2- Dichloroethane	<5	5
1,1- Dichloroethene trans-	<5	5
1,2- Dichloroethene 1,2-	<5	5
Dichloropropane cis-1,3-	<5	5
Dichloropropene trans-1,3-	<5	5
Dichloropropene Ethyl	<5	5
Benzene	<5	5
Methylene chloride	<5	5
Styrene	<5	5
1,1,2,2- Tetrachloroethane	<5	5
Tetrachloroethene	<5	5
Toluene	<5	5
1,1,1- Trichloroethane	<5	5
1,1,2- Trichloroethane	<5	5
Trichloroethene	<5	5
Trichlorofluoromethane	<10	5
Vinyl chloride	<5	10
<u>Xylene (total)</u>		5

**APPENDIX G. High Flow Organic Water Quality Data Summary for Point H-6 for PSU
Project HOFU sample 11-18-93.**

Parameter	Concentration (ug/l)	Detection Limit
Acrolein	<5	5
Acrylonitrile	<5	5
Benzene	<5	5
Biomodichloromethane	<5	5
Biomofom	<5	5
Biomomethane	<10	10
Carbon tetrachloride	<5	5
Chlorobenzene	<5	5
Chloroethane	<10	10
2- Chloroethylvinyl ether	<5	5
Chloroform	<5	5
Chloromethane	<10	10
Dibromochloromethane	<5	5
1,1- Dichloroethane	<5	5
1,2- Dichloroethane	<5	5
1,1- Dichloroethene	<5	5
trans-1,2- Dichloroethene	<5	5
1,2- Dichloropropane	<5	5
cis-1,3- Dichloropropene	<5	5
trans-1,3- Dichloropropene	<5	5
Ethyl Benzene	<5	5
Methylene chloride	<5	5
1,1,2,2- Tetrachloroethane	<5	5
Tetrachloroethane	<5	5
Toluene	<5	5
1,1,1- Trichloroethane	<5	5
1,1,2- Trichloroethane	<5	5
Trichloroethene	<5	5
Vinyl chloride	<10	10