Geohazard Conditions Report

Volkman Housing project
Spokane County, WA

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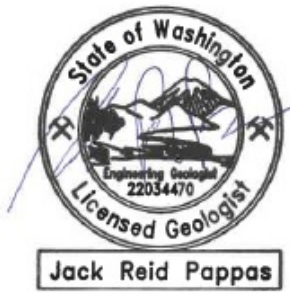

1/24/2025

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BAI Project Number: G22525

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CONTEXT

This geohazard evaluation presents the results of geologic research and reconnaissance of the subject property. These services were contracted with Whipple Consulting Engineers, represented by Todd Whipple, PE.

Project Considerations

An approximately 124.5-acre site is proposed for residential development. Current plans indicate development of the northern half of the site will consist of 347 single-family lots. Approximately 38 acres of the development is proposed on slopes greater than 30 percent.

We previously completed a geotechnical engineering report for the property dated August 19, 2022.

Location

The site is in the W ½ of the SE ¼ of Section 16 and the E ½ of Section 21, Township 26N, Range 42E, Willamette Meridian. Spokane County lists the 10 parcel numbers as 26164.0046, -.0018, -.0031; 26211.0201, -.0211, -.0101, -.0054, -.0057; and 26214.0051, -.0058. The physical addresses of 9802 and 9702 N. Nine Mile Road, Highway 291, are assigned to existing houses on the northern two parcels. The location is illustrated in the *Vicinity Map* and *Site Plan*.

Scope

The scope of services included:

- Review of readily available geologic and soil information;
- Field reconnaissance of the subject property;
- Evaluation of pertinent geologic and hydrologic conditions at the site based on visual observations;
- Development of professional opinions relating to potential geologic hazards as defined by the Spokane County Critical Areas Ordinance (CAO); and,
- Preparation of a letter report documenting our conclusions.

This report addresses only conclusions as to the potential geohazards associated with the slopes and erodible soils associated with development. The conclusions are based on visual observations of the ground surface conditions and our review of the published data. Soil or other geotechnical parameters associated with foundation design, wall design, structural fill, bearing capacity, or seismic criteria are addressed in the August 22, 2022 report.

ENCOUNTERED CONDITIONS

Physical Setting

The site is northwest of Spokane and west of the Five Mile Prairie, a large basalt terrace.
Multiple lava flows of the Columbia River Basalt Group blanketed the Spokane region during the Miocene. The Latah fault, an inferred northwest-southeast topographic lineament, is located just west of the site. The fault was mapped using topographic lineaments and stratigraphic offsets in the Miocene Latah Formation and Grande Ronde Basalt flows across the Latah Creek watershed. Flows of the Priest Rapids member of the Wanapum Basalt overlie both units on either side of the fault and do not exhibit appreciable offset, suggesting that most movement on the Latah fault occurred prior to the eruption of the Priest Rapids flows approximately 14.3 million years ago (WSDNR, 2012).

During the last ice age, repeated cataclysmic flood events resulting from rupturing of the ice dams that retained Glacial Lake Missoula, inundated much of the Spokane area, and scoured pre-existing rock and sedimentary formations. The floods deposited coarse-grained sediment in consequentially developed and localized channels.

Several north-south trending alluvial terraces, deposited by the outburst floods, extended down to the west from the top of the Five Mile Prairie to the site. An approximately 250-foot-tall alluvial terrace was located on and directly east of the site and sloped down to the west at 30 to 60 percent. Multiple draws were observed in the terrace and eroded material formed small alluvial fans at the mouth of the draws. The present-day Spokane River meanders through a large-scale channel incised into the basalt and outburst flood deposits.

Geologic mapping of the area shows the site is underlain by Quaternary alluvium (*Qal*), Quaternary alluvial fan deposits (*Qaf*), and Pleistocene outburst flood deposits, predominantly sand (*Qfs*) (WSDNR, 2004). The Natural Resources Conservation Service (NRCS) lists the native soils associated with the site as described below in *Table 1*.

Table 1. NRCS Soil Units

Soil Unit Number	Soil Unit Name	Slopes	K Factor, Whole Soil
3120	Marble loamy Sand	0 to 8 percent	0.05
3121	Marble loamy Sand	8 to 15 percent	0.05
3122	Marble loamy Sand	15 to 30 percent	0.05
3123	Marble loamy Sand	30 to 55 percent	0.05
3127	Marblespring fine gravelly loamy coarse sand	0 to 8 percent	0.05
3140	Springdale gravelly ashy coarse sandy loam	0 to 8 percent	0.20
3143	Spens very gravelly loamy coarse sand	30 to 65 percent	0.15
3147	Spens very gravelly loamy coarse sand, cool	15 to 30 percent	0.15
3148	Spens very gravelly loamy coarse sand, cool	30 to 65 percent	0.15
7116	Urban Land-Marblespring, disturbed complex	3 to 8 percent	0.10
7120	Urban land-Marble, disturbed complex	0 to 3 percent	0.10
7121	Urban land-Marble, disturbed complex	3 to 8 percent	0.10
7122	Urban land-Marble, disturbed complex	8 to 15 percent	0.10
7123	Urban land-Marble, disturbed complex	15 to 30 percent	0.10
7170	Urban land-Springdale, disturbed complex	0 to 3 percent	0.20

Field Reconnaissance

We visited the site on July 20th, 2022. The site primarily consisted of undeveloped land. Total relief across the site was approximately 268 feet. The highest point of elevation was observed in the northeast corner at approximately 1,940 feet (NAVD 88) and the lowest point was approximately 1,672 feet near the southeast corner where a power line alignment leaves the site (discussed subsequently). A 30 to 60 percent slope was located on the eastern and southern halves, sloping down to the west. The slope was moderately populated by coniferous trees and the ground surface was blanketed with forest duff. The lower, western half sloped gently to the northwest and was populated by tall-growing grasses and weeds. Historical aerial imagery indicated that the western half bordering Highway 291 was previously used for agricultural purposes.

An existing home was observed on the east side of the site. The house was built on level pads

constructed by cut and fill methods. At the center of the northern boundary of the site, fill was observed in an area possibly used as a borrow pit. High-voltage powerlines were observed on an easement from the northwest corner to the southwest corner. On the southern half, a road was cut into the slope beneath the power lines. Near the top of the road, an erratic, approximately 8-foot diameter boulder was observed. Several indications of buried gas and communication lines were observed perpendicular to Pine Meadows Road.

Indications of soil instability (scarps, slumps, pistol-butted trees, etc.) were not observed. Several eroded areas were observed along the powerline service road. The eroded areas were downslope of water bars graded into the road.

Surface water was not observed on the site. The nearest surface water was observed in the Spokane River, approximately ½ mile southwest of the site. The surface water elevation in this reach of the river is controlled by the Nine Mile Falls Dam, approximately 2.5 miles to the northwest. Normal pool elevation above Nine Mile Falls Dam is 1,604 feet (USGS, 1973).

A review of local well reports obtained from the Washington State Department of Ecology website indicate the depth to groundwater in the vicinity of the site is approximately 67 feet below ground surface .

Review of chapter 6.2 in the *Spokane Regional Stormwater Manual* (SRSM) indicates the site is within the aquifer sensitive area (ASA) and the moderate to high susceptibility range for the critical aquifer recharge area (CARA), shown in *Figure 6-1* and *Figure 6-2*, respectively.

GEOLOGIC HAZARDS

The CAO requires evaluation of geologically hazardous areas, principally erosion, landslide, and seismic hazards (Section 11.20.030 Table A, and 11.20.070 d.2). The purpose of the ordinance is to discourage development in geologically hazardous areas unless proponents demonstrate that such areas can be developed consistent to acceptable standards for public health and safety.

Based on this ordinance, geohazard areas in Spokane County exhibit at least one of the following characteristics:

- *a. A slope of 30 percent or greater;*
- *b. Soils identified by Natural Resource Conservation Service (NRCS) as posing a severe potential for erosion (see Section 11.20.090L Appendix L);*
- *c. Hydraulic factors such as existing on-site surface and groundwater or changes in hydraulic factors, caused by proposals that create a severe potential for erosion or landslide hazard;*
- *d. Areas that historically have been prone to land sliding or with one of the following geologic formations: alluvium, landslide deposits, Latah Formation;*
- *e. Areas of uncompacted fill;*
- *f. Areas that are unstable as a result of rapid stream or stream bank erosion;*
- *g. Seismic hazards include the following areas identified on the Liquefaction Susceptibility Map of Spokane County, Washington (source: Washington State Department of Natural Resources, Sept. 2004):*
    - *i. For public buildings and public assembly buildings and uses those areas classified as having a liquefaction susceptibility of moderate; and*
    - *ii. For all buildings and public assembly uses those areas classified as having liquefaction susceptibilities of "moderate to high", "high", or "peat deposit."*

h. Seismic hazards include the following areas identified on the Site Class Map of Spokane County, Washington (source: Washington State Department of Natural Resources, Sept. 2004):

i. For public buildings and public assembly buildings and uses those areas classified as having a site class of "D"; and

ii. For all buildings and public assembly uses those areas classified as having a site class of "D to E", "E", or "F."

A review of readily available information and site observations indicated components *a*, *b*, *d*, and *e* of the CAO, as described above, were observed on site. Other components of the CAO were not observed. Geohazards are further addressed in the following report sections.

DISCUSSION

Geologic Hazards. Geologic hazards identified on the site, as defined by the CAO are slopes greater than 30 percent, soils identified by the NRCS as posing a severe potential for erosion, areas mapped as alluvium, and areas of uncompacted fill. The extent of these hazards were delineated in *Figures 2-2,* to *2-5* utilizing GIS data obtained from the Washington State Department of Natural Resources and Spokane County.

We used the modified version of the Universal Soil Loss Equation (USLE) outlined in Section 11.20.090 L Appendix L in the CAO to determine whether soils pose a severe potential for erosion. *"The index is a product of K times the average slope of the map unit (K*ave slope). Slight has an index of less than or equal to 3.0 (less than 5 tons/acre/yr.), moderate has an index of 3.0 to 4.0 (5 to 8 tons/acre/yr.), and severe has and index greater than 4.0 (greater than 8 tons/acre/yr.)." Table 2* lists slopes that pose severe potential for erosion based on the equation outlined above. The potential for erosion, based on the parameters in *table 2*, is illustrated in *Figure 2-5, Soil Erosion Hazard Map*. Soils identified as posing a severe potential for erosion are located on and north of the northern edge of the site, outside the proposed development.

Table 2. Modified USLE Index Parameters.

K Factor, Whole Soil	Potential for Severe Erosion
0.05	Greater than 80 percent slopes
0.10	Greater than 40 percent slopes
0.15	Greater than 27 percent slopes
0.20	Greater than 20 percent slopes

Quaternary alluvium (*Qal*) was mapped by the WSDNR on parts of the site, as illustrated in *Figure 2-2*. The encountered soils were coarse-grained, well consolidated, and formed relatively gentle slopes. In the areas mapped as alluvium, we did not observe evidence of erosion or landslide hazards during our surface reconnaissance and subsurface explorations.

Although geologic hazards are present, we conclude these hazards can be mitigated by use of typical construction best management practices, preservation of natural drainages, and following the recommendations outlined in this report.

We recommend retaining qualified professionals to complete erosion and sediment control plans, civil engineering and stormwater design, and geotechnical exploration and analysis.

LIMITATIONS

The conclusions presented herein represent our professional opinions based on the limited scope of work performed to date. This report is intended for the sole use of our client for the purposes stated herein and should not be used by other parties for other purposes without contacting us to provide specific evaluation and recommendations. Specific geotechnical evaluation and design for construction is beyond the scope of this report.

The client should expect these services to have been completed in a manner consistent with the level of skill and care ordinarily exercised by members of the profession currently practicing in this area with similar budget and time constraints on projects of similar size and scope. No express or implied warranties are offered or made.

Be aware that geohazard evaluation reports do not substitute for geotechnical engineering evaluations to design earthwork, slopes, walls, roads, utilities, stormwater facilities, structures, and earthwork.

Please contact us if you have questions or concerns regarding the information presented herein.

REFERENCES

United States Department of Agriculture, 2020, Natural Resources Conservation Service. *Web Soil Survey*. Available online at https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

United Stated Geologic Survey (USGS), 2020, Airway Heights, WA, 7.5-minute Quadrangle, 1:24,000

USGS, 2020, Nine Mile Falls, WA, 7.5-minute Quadrangle, 1:24,000

USGS, 2020, Dartford, WA, 7.5-minute Quadrangle, 1:24,000

USGS, 2020, Spokane, WA, NW 7.5-minute Quadrangle, 1:24,000

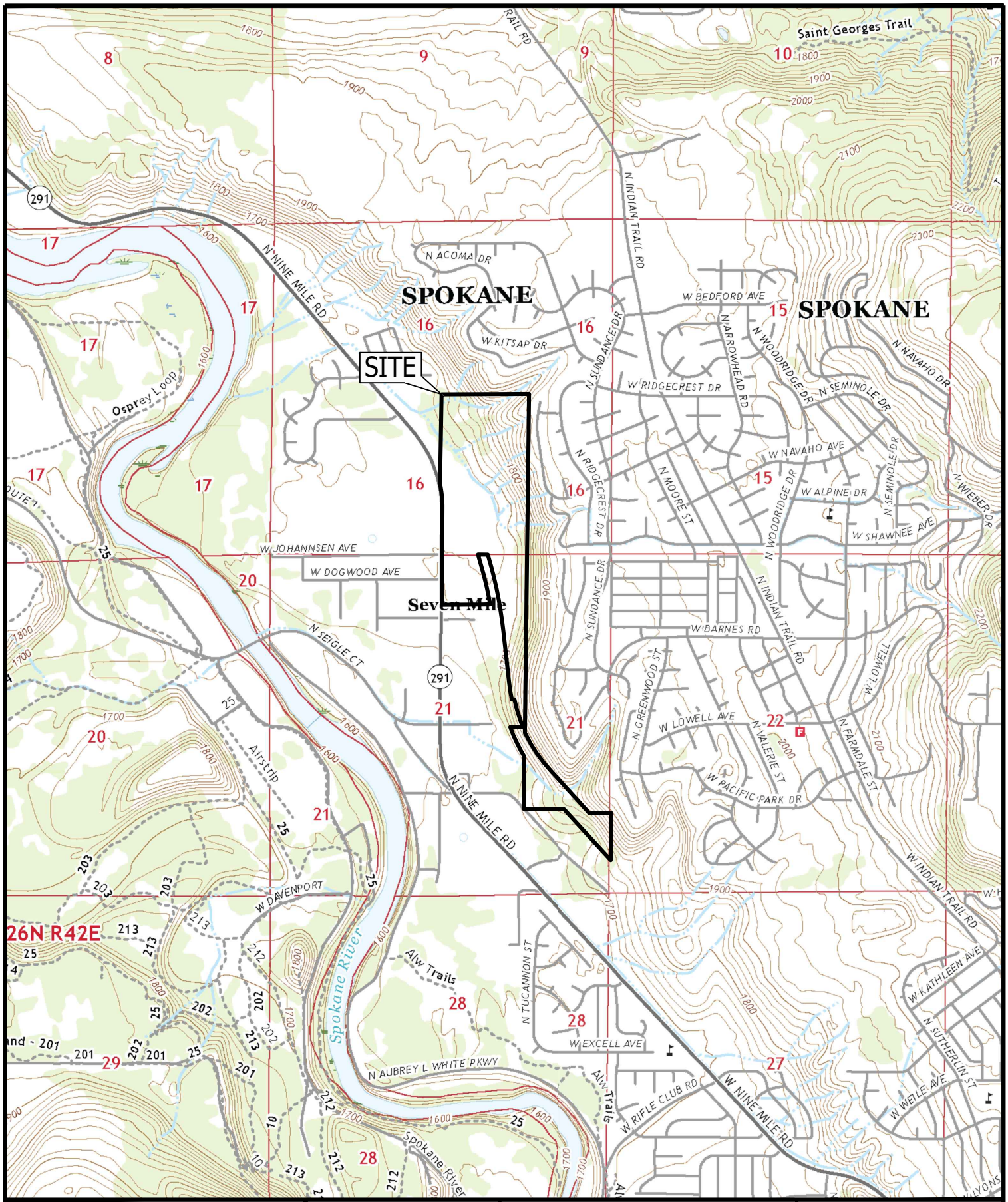
Washington Military Department, Emergency Management Division; Washington Department of Natural Resources; U.S. Geological Survey; Federal Emergency Management Agency, 2012, Understanding earthquake hazards in Washington State--Modeling a magnitude 5.5 earthquake on the Latah fault zone in Spokane County.

Washington State Department of Natural Resources, (WSDNR), Geologic map of the Airway Heights 7.5-minute quadrangle, Spokane County, Washington, by R. E. Derkey, M. M. Hamilton, and D. F. Stradling. 2004.

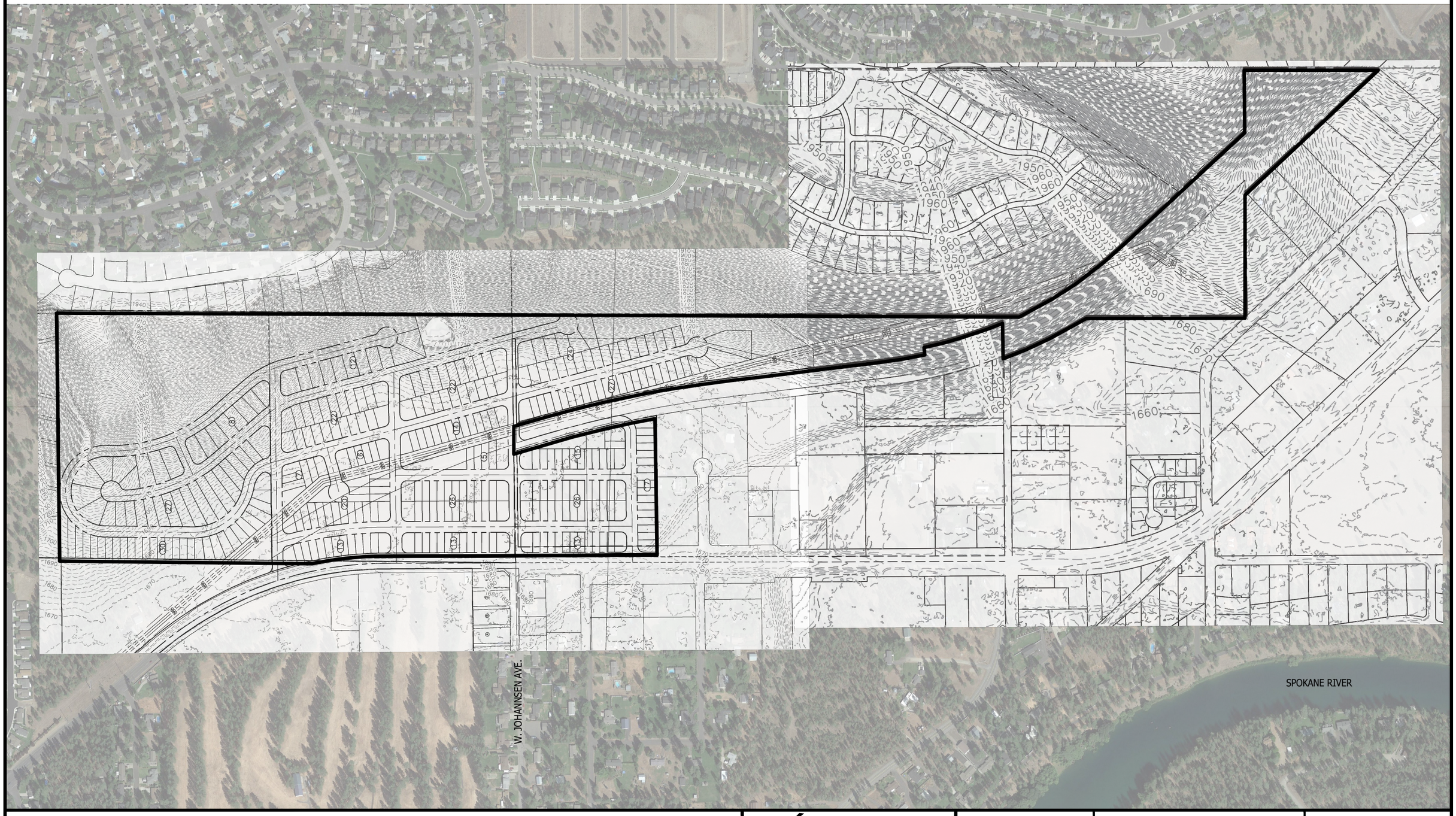
WSDNR, Geologic map of the Dartford 7.5-minute quadrangle, Spokane County, Washington, by R. E. Derkey, W. J. Gerstel, and R. L. Logan. 1998.

WSDNR, Geologic map of the Nine Mile Falls 7.5-minute quadrangle, Spokane and Stevens Counties, Washington, by R. E. Derkey, M. M. Hamilton, and D. F. Stradling. 2003.

WSDNR, Geologic map of the Spokane Northwest 7.5-minute quadrangle, Spokane County, Washington, by R. E. Derkey, M. M. Hamilton, and D. F. Stradling. 2004.



N SCALE: 1"=2000' 0 1000 2000	SECTIONS 16 & 21 T 26 N R 42 E USGS, 2020	Budinger & Associates	VICINITY MAP VOLKMAN HOUSING PROJECT SPOKANE, WASHINGTON	FIGURE 1 PROJECT NUMBER G22525 DATE: 8/2022



BASE PLAN PROVIDED BY:
WHIPPLE CONSULTING ENGINEERS
(DATED 09/04/2020)

SCALE: 1"=500'
0 250 500

SECTIONS 16 & 21
T 26 N R 42 E
USGS, 2020

Budinger & Associates

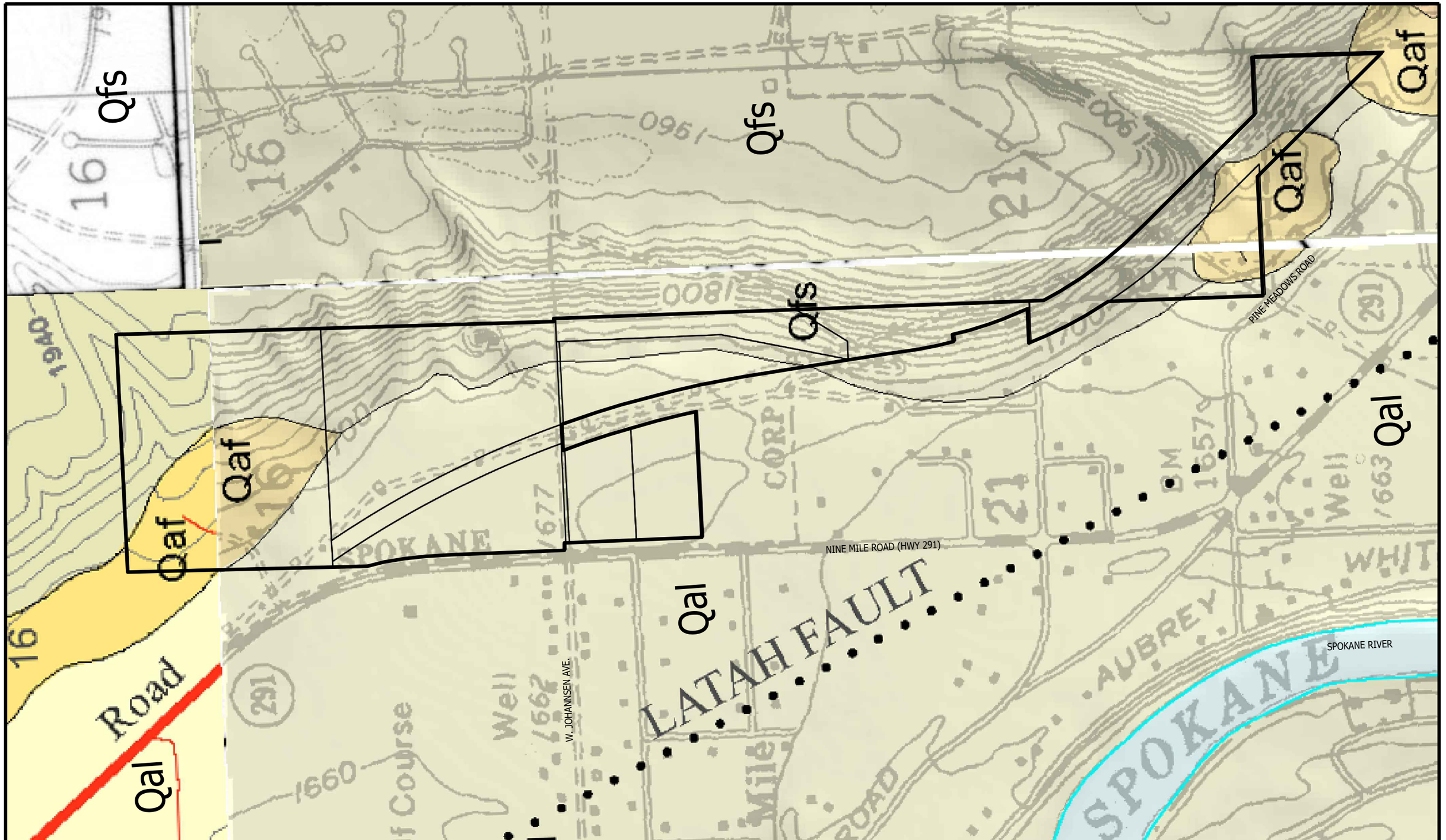
SITE PLAN

VOLKMAN HOUSING DEVELOPMENT
NINE MILE FALLS, WASHINGTON

FIGURE 2-1

PROJECT NUMBER G22525

DATE: 8/2022



Qal - QUATERNARY ALLUVIUM

Qaf - QUATERNARY ALLUVIAL FAN DEPOSITS

Qfs - PLEISTOCENE OUTBURST FLOOD DEPOSITS, PREDOMINANTLY SAND

GEOLOGIC MAPS PROVIDED BY WADNR

SCALE: 1"=500'

0 250 500

SECTIONS 16 & 21
T 26 N R 42 E
USGS, 2020

Budinger & Associates

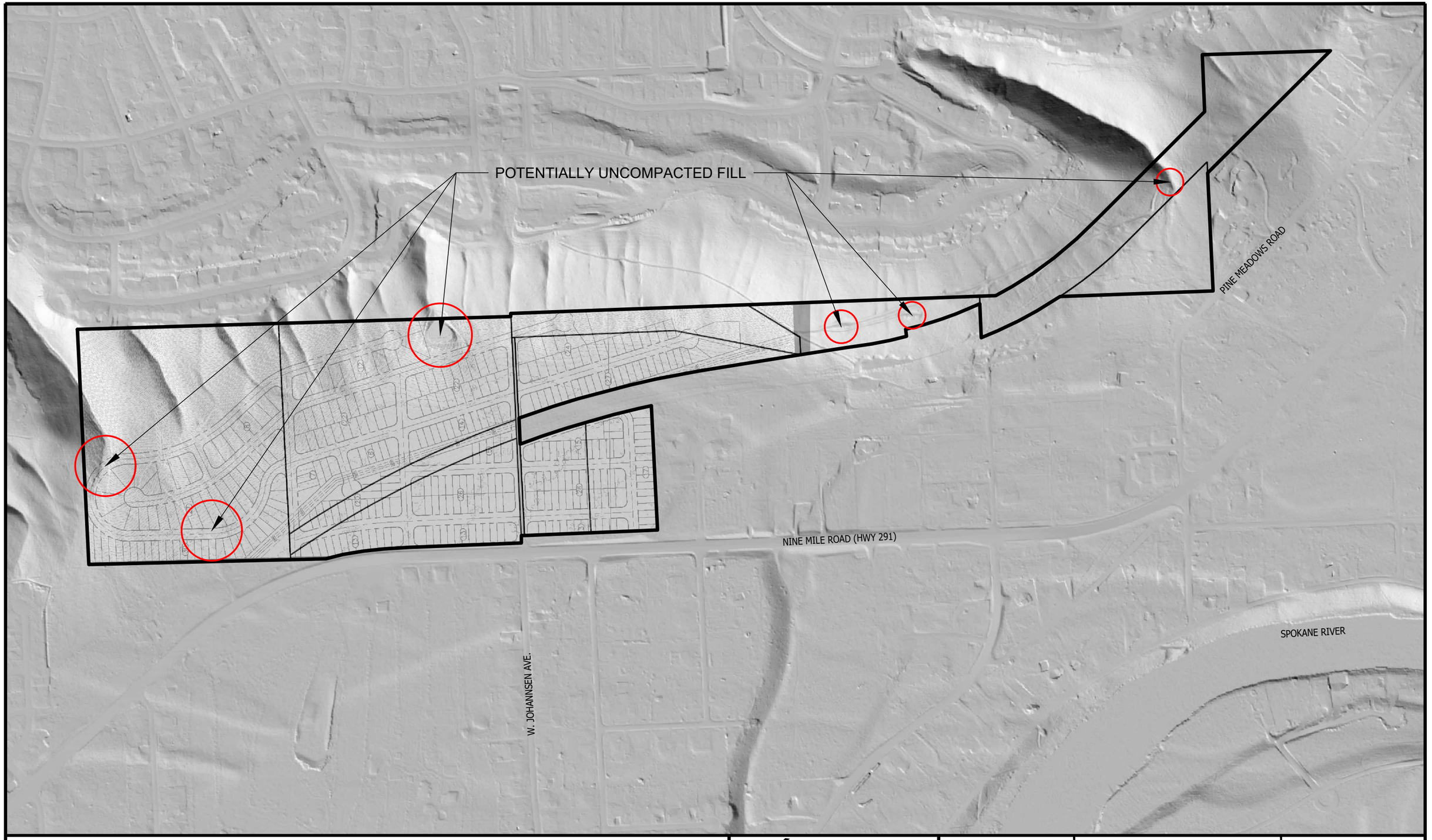
GEOLOGIC MAP

VOLKMAN HOUSING DEVELOPMENT
NINE MILE FALLS, WASHINGTON

FIGURE 2-2

PROJECT NUMBER G22525

DATE: 8/2022



AREAS IDENTIFIED AS POTENTIALLY UNCOMPACTED FILL

BASE PLAN PROVIDED BY:
WHIPPLE CONSULTING ENGINEERS
(DATED 09/04/2020)
LIDAR IMAGERY PROVIDED BY WADNR

SCALE: 1"=500'
0 250 500

SECTIONS 16 & 21
T 26 N R 42 E
USGS, 2020

Budinger & Associates

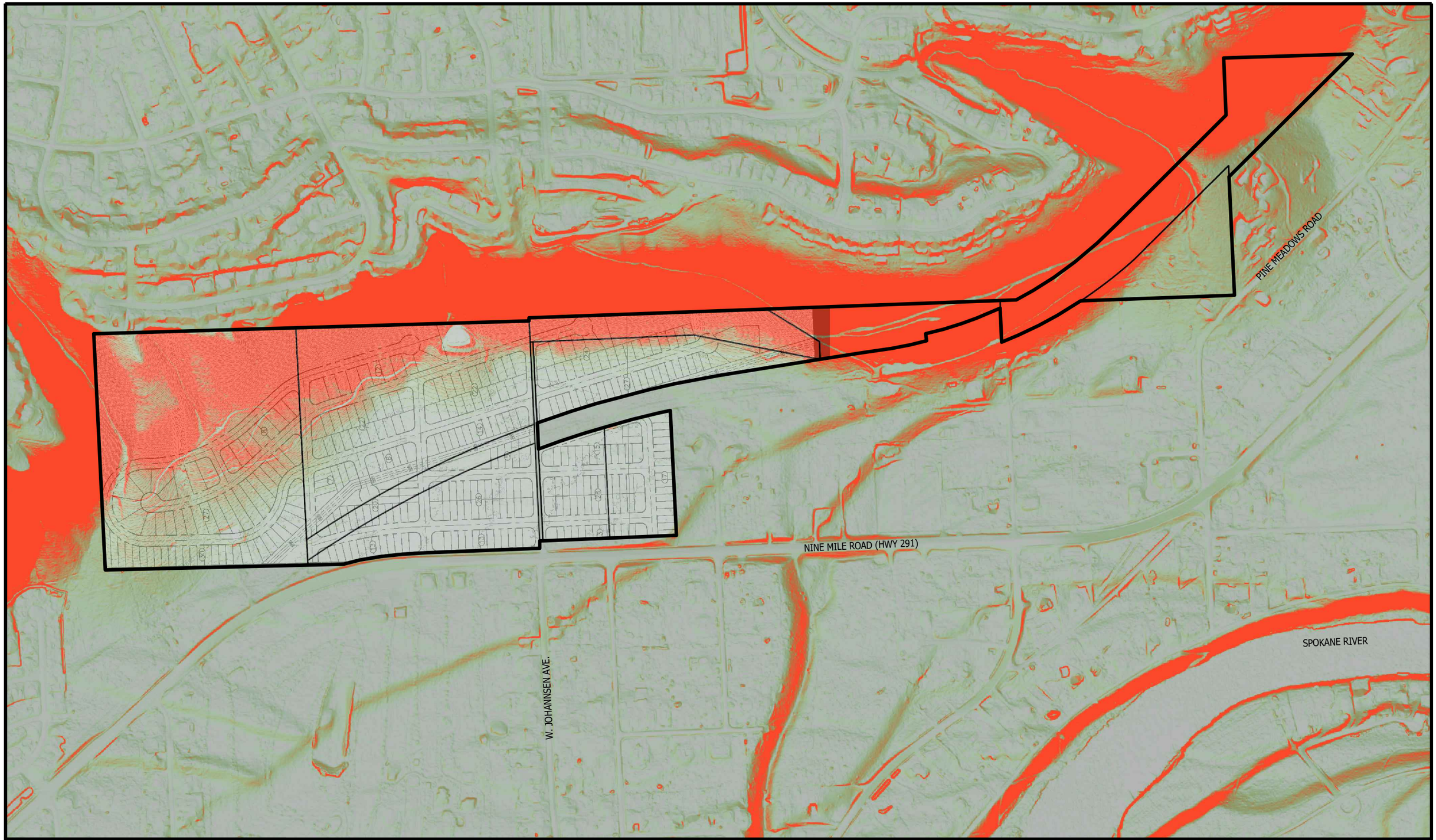
HILLSHADE (LIDAR)

VOLKMAN HOUSING DEVELOPMENT
NINE MILE FALLS, WASHINGTON

FIGURE 2-3

PROJECT NUMBER G22525

DATE: 8/2022



Slopes Less than 30 percent
Slopes greater than 30 percent

BASE PLAN PROVIDED BY:
WHIPPLE CONSULTING ENGINEERS
(DATED 09/04/2020)
LIDAR IMAGERY PROVIDED BY WADNR

SCALE: 1"=500'
0 250 500

SECTIONS 16 & 21
T 26 N R 42 E
USGS, 2020

Budinger & Associates

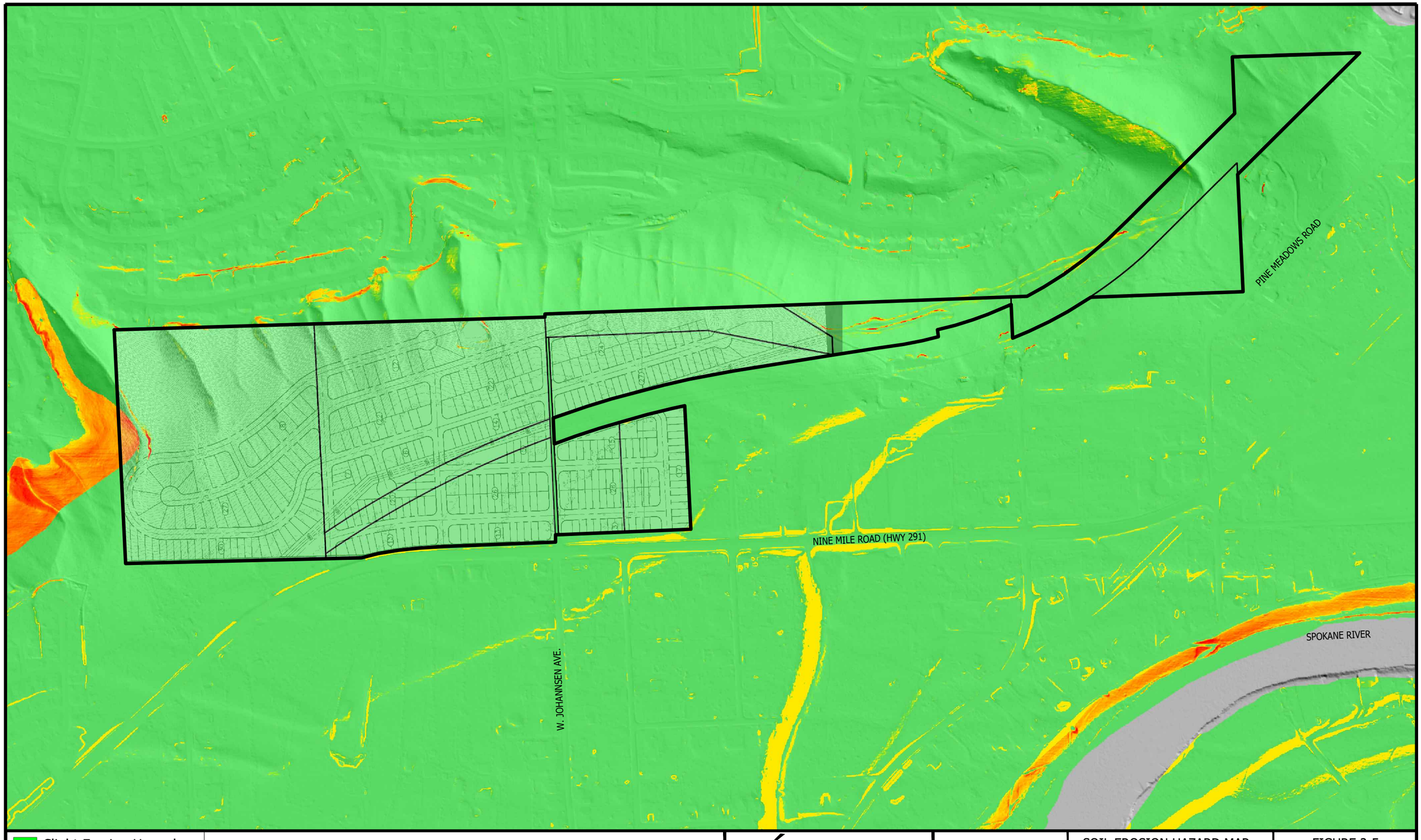
SLOPES GREATER THAN 30%

VOLKMAN HOUSING DEVELOPMENT
NINE MILE FALLS, WASHINGTON

FIGURE 2-4

PROJECT NUMBER G22525

DATE: 8/2022



Slight Erosion Hazard
Moderate Erosion Hazard
Severe Erosion Hazard

BASE PLAN PROVIDED BY:
WHIPPLE CONSULTING ENGINEERS
(DATED 09/04/2020)
LIDAR IMAGERY PROVIDED BY WADNR

SCALE: 1"=500'
0 250 500

SECTIONS 16 & 21
T 26 N R 42 E
USGS, 2020

Budinger & Associates

SOIL EROSION HAZARD MAP

VOLKMAN HOUSING DEVELOPMENT
NINE MILE FALLS, WASHINGTON

FIGURE 2-5

PROJECT NUMBER G22525

DATE: 8/2022

Appendix A: ***GBC - Important Information About Your Geotechnical Report***

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical- engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply this report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical-engineering report whose adequacy may have been affected by*: the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Contact the geotechnical engineer before applying this report to determine if it is still reliable.* A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. *Confirmation-dependent recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members' misinterpretation of geotechnical-engineering reports has resulted in costly

problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Environmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold- prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical- engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; *none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.*

Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance

Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you GBC-Member geotechnical engineer for more information.

GEOTECHNICAL BUSINESS COUNCIL
of the Geoprofessional Business Association

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