Golder Associates Inc.
CONSULTING ENGINEERS

ATTACHMENT A

INSTALLATION OF GROUNDWATER EXTRACTION WELL AND MONITORING WELL FOR MITIGATION OF LEACHATE-IMPACTED GROUNDWATER FLOW INTO THE NORTH STORM WATER DETENTION POND CATHCART LANDFILL, SNOHOMISH, WASHINGTON

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1. INTRODUCTION

The scope of work described herein includes the installation of an efficient groundwater extraction system designed to intercept potentially impacted groundwater flowing beneath the Cathcart Landfill and redirect the extracted water into the existing leachate collection and treatment system. The primary system will consist of a large-diameter extraction well and pumping system, designated W-2, capable of removing groundwater at flow rates of between 10 and 20 gallons per minute. The borehole and well will be recessed approximately 13 feet into bedrock in order to create a groundwater sump and increase the hydraulic capacity of the well. The pumping system to be installed will include an electrical submersible pump, controlled by a fluid level control system. Discharge from the pump will be routed to an nearby sump for ultimate distribution in the existing leachate treatment system. All distribution piping must be installed subgrade and below normal freezing zones and tied into existing discharge piping leading to the sump.

A second well, designated G-7, will be used as a monitoring well, and will be installed to enable monitoring of hydraulic conditions some distance away from the primary extraction well. This well must also be capable of being used as a groundwater extraction well at times of high groundwater flow. However, the installation of a pumping and distribution system in this well is not included in this scope of work.

Both wells are to be installed in 10-inch diameter boreholes. The boreholes shall be drilled using air-rotary methods with driven temporary steel casing. Total depth of the extraction well borehole is expected to be approximately 60 feet, or 13 feet beneath the local bedrock surface. Total depth of the monitoring well borehole is expected to be approximately 50 feet and will also be recessed 13 feet beneath the bedrock surface. The exact drilling sequence and screened intervals will be directed in the field by a qualified on-site hydrogeologist. Total project drilling footage is expected to be approximately 110 feet.

Both wells are to be installed within the Cathcart Landfill property, located near Snohomish, Washington. A layout of site operations and proposed well locations, is provided in Figure 1.

Regulatory considerations pertaining to the installation of wells in the State of Washington are presented in Section 2. General work specifications and conduct of the work is discussed in sections 3 and 4 respectively. Borehole drilling procedures are outlined in Section 5, while well materials and installation procedures are provided in Sections 6 and 7, respectively. Well development and acceptance is discussed in Section 8. The extraction well pumping system is discussed in Section 9 and the groundwater distribution system is covered in Section 10.

2. REGULATORY CONSIDERATIONS

The wells have been designed to water well standards required by the State of Washington as outlined in WAC 173-160 and WAC 173-162. A State of Washington licensed water well driller will be required to be present on site during all drilling, and well installation activities. The State of Washington licensed water well contractor will be required to file two reports with the Washington Department of Ecology:

- "Start Card" Notice of intent to drill and install a well filed at least 72 hours prior to beginning the work.
- Well Completion Form - Water Well Drillers report. Filed within 30 days of the completion of the work.

Copies of completed reports will also be submitted to Golder Associates Inc. Start card numbers must be available to the site hydrogeologist upon request.

3. GENERAL WORK SPECIFICATIONS

3.1 Work Included

The work includes, but is not limited to:

- Obtaining all necessary state and/or local permits and licenses for the drilling and construction of the extraction well and the monitoring/extraction well, including filing notice of intent to drill ("Start Card") and well driller's report(s). Driller must have water well drilling certification from the State of Washington, and must have a certified water well driller at the drill site during drilling and installation of the wells.

- Furnishing all supervision, labor, drilling equipment, tools, supplies and materials to construct and develop the extraction well and monitoring/extraction well, and install the pumping system and discharge piping system.

- Air rotary drilling two boreholes and installation of well screen and riser pipe for the extraction well and monitoring/extraction well. The wells will be backfilled with a filter pack, bentonite seal, and grout surface seal.

- Developing the extraction well and the monitoring/extraction well.

- Piping and/or hauling water to the work areas as required for drilling and testing.

- Obtaining cutting samples and selected drive samples from the boreholes.

- Containing and disposing of cuttings and water produced during drilling and development operations. On-site disposal on the existing landfill is anticipated. Disposal procedures will be directed by the site hydrogeologist.

- Constructing a subsurface wellhead which will contain all pump controls, flow meter, check valve, and discharge piping. The wellhead must contain a drain system capable of keeping all above-well systems dry.

- Installation of the groundwater extraction system which will consist of an electrical submersible pump, electrical wiring and pump control box, discharge piping, fluid-level pump control system, pump shield, and water level probe access tube.

- Constructing a subsurface piping system which ties the pump discharge into the existing discharge system emanating from the former extraction well, W-1, and discharging to Flow Meter Vault C-FV-1 and Sump SP-1. This will

include excavation of a trench from well W-2 to the closest location of the W-1 discharge pipe, installation of the discharge pipe, attaching a T-fitting to the W-1 discharge pipe and tying into it with the new W-2 discharge pipe. All piping must be installed below the expected freezing zone (minimum depth 3 feet) and must be leakproofed. Every effort shall be made to install a piping system which will allow all extracted groundwater to gravity feed into the existing piping system.

- Cleaning and restoring the work areas to their original conditions.

3.2 Work Not Included

- Obtaining property access and right-of-way.
- Locating and surveying well sites.
- Building access roads and drill pads.
- Electrical hookups, other than attaching power leads from the pump to the control box.

3.3 Access to Work/Site Security

Golder Associates Inc. will secure permission to the work site through an agreement with the Snohomish County Department of Public Works. The Contractor shall provide his own means of moving equipment to the location of each well or excavation. The Contractor may use available existing site roads and shall be responsible for the maintenance and repairs of such roads to the conditions as existed immediately prior to start of use by the Contractor. Every attempt shall be made to minimize the need to drive over areas outside of the existing roads. All fences and gates shall be left in the manner in which they were found. The drilling sites are located within the bounds of an active landfill site and precautions must be made not to disrupt normal operations.

4. CONDUCT OF THE WORK

4.1 Execution and Quality of Work

The Contractor shall control the quality of items and services to meet the requirements of this scope of work, applicable codes and standards, and other contract documents. The work shall be conducted in close coordination with the site hydrogeologist so that preliminary results can be reviewed as they become available.

4.2 Personnel

A Foreman or Foreman/Driller, designated by the Contractor, shall have complete charge of the work. The drilling crew(s) shall be comprised of experienced and competent drilling personnel. If, during the course of the drilling operation, the Driller or the drilling crew do not appear to be competent or are not following the guidelines outlined in this scope of work, they may be removed from the site at the request of the site hydrogeologist, or the Owner.

During the drilling operation, the Contractor shall keep an accurate log of the top and bottom depth and description of each stratum penetrated during the drilling of each boring as well as the ground water/moisture characteristics disclosed by drilling. The Contractor shall provide copies of the log of each borehole and installed well to the site hydrogeologist as per Section 2 Regulatory Considerations.

4.3 Drilling Equipment and Methods

The Contractor will supply a fully operational drill rig(s) and maintain sufficient equipment, materials, parts, tools, and supplies to meet the requirements for the work. The equipment shall be capable of providing the required hole diameter at the required drilling depths. All accessories for the drilling and sampling, and other materials or supplies necessary for the work, shall be furnished by the Contractor unless otherwise specified herein. The equipment shall be in satisfactory operating condition and capable of performing the work set forth herein safely and efficiently. Each boring shall be advanced using rotary drilling techniques with air used to return the cuttings. The compressor shall deliver a sufficient volume and pressure to create adequate up hole velocities for efficient removal of cuttings and water. The rotation speed and drill advance rate shall be low enough that cuttings are blown or flushed from the borehole and do not clog the casing. Other drilling techniques may be used if approved by the hydrogeologist.

Equipment shall be available for inspection prior to beginning the work, and shall be subject to inspection by the hydrogeologist at all times during the work. If deemed unsatisfactory, the equipment shall be removed from the work site and replaced by satisfactory equipment at the expense of the Contractor.

4.4 Abandoned Borings

Borings abandoned before reaching the specified final depth because of mechanical failure of drilling equipment, negligence or operation error on the part of the Contractor or other such preventable causes, and rejected by the hydrogeologist will not be paid for. Any borings rejected shall be supplemented by another boring adjacent to the first at the expense of the Contractor.

Unless otherwise required by the site hydrogeologist, each abandoned boring shall be filled with a cement/bentonite grout to the top of the hole. The grout shall be placed by placing rods, pipe or hose to the bottom of the hole and pumping the grout into the boring at the bottom until the grout reaches the top. Should loss or shrinkage of grout occur, borings shall be refilled until they remain full.

In the event the replacement boring is lost, it in turn shall be replaced by another. Regardless of the reason for abandoning a boring, no payment will be made for moves and setup in order to drill a new boring at an adjacent location.

4.5 Technical Inspection

Golder Associates Inc. will be represented by a qualified hydrogeologist who will attend the drilling, construction, development and testing of the wells, pump installation, and installation of pump discharge distribution system. The hydrogeologist may prepare progress reports and logs of the boreholes during drilling, and will determine the conduct of all associated testing. Such attendance shall not relieve the Contractor from keeping adequate records as required by this Specification.

4.6 Assistance in Checking Work

Every assistance shall be given by the Contractor to the site hydrogeologist to note and obtain knowledge of each and every occurrence in the progress of the work. No hole shall be abandoned or completed before the site hydrogeologist shall be afforded the opportunity to verify the geologic conditions, depth of hole, well completion specifications, and other pertinent information.

4.7 Water Supply

The Contractor shall provide all water necessary to perform the work. The equipment required may include pumps, water trucks or trailers, hoses, storage tanks and all other items necessary to provide an adequate water supply. The Contractor shall supply a water truck for use during drilling. The source of water is subject to approval by the site hydrogeologist. All discharge water shall be contained and handled in an environmentally acceptable manner. All cuttings and discharge water are to be contained for on-site

disposal on the landfill.

4.8 Water, Fuel, and Power

The Contractor shall provide all fuel, water, and power necessary to complete the job as specified at his own expense.

4.9 Buried Utilities

The Snohomish County Department of Public Works will provide the Contractor with as-built diagrams which outline the locations of utilities at the Cathcart Landfill site. However, it is the Contractor's responsibility to determine the existence and location of any underground utilities within a 50-ft radius of staked boreholes. The Contractor shall be liable for repair of any damaged utilities resulting from his operations.

The Contractor shall locate existing overhead power lines before proceeding with the work and not permit machinery, men, or equipment to come within 20 ft of overhead power lines.

4.10 Security

The Contractor shall be responsible for providing security for equipment, materials, tools, etc., in his care.

4.11 Protection of Materials and Work

The Contractor shall at all times carefully and properly protect all materials, both before and after being used on the job, as well as all work performed by him, and provide any special protection from the weather deemed necessary without additional cost to the Owner. Materials shall be stored so as to insure the preservation of their quality and utility for the work.

4.12 Mobilization or Demobilization

The mobilization cost specified by the Contractor shall include all costs of the Contractor for transportation of equipment and materials to the job site, until he is set up and ready to drill on the first borehole for each piece of equipment and the cost of moving out to his next contract or base of operations after completion of the tasks specified in this contract.

4.13 Termination at Top of Well

At all times during the progress of the work the Contractor shall use reasonable precautions to prevent either tampering with the wells, the pump system, the piping system, or the entrance of foreign material into the wells.

4.14 Cleanup

The Contractor shall, at his expense, maintain all portions of the work in a neat, clean, and sanitary condition. Before completion of this Contract, the Contractor shall: remove drilling machinery and equipment; satisfactorily dispose of rubbish resulting from operations under this Contract; and do work necessary to restore the area of his operations to a condition satisfactory to the Owner. Disposal of drilling fluid and water from the boring and drill cuttings shall be at the direction of the site hydrogeologist.

4.15 Safety

The contractor shall at all times operate his equipment in a safe manner to prevent injury or damage to personnel, equipment or materials. Federal and State Laws relating to the public must be observed and all lawful orders of agencies of the state or Federal Government charged with maintaining the personal safety of employees shall be observed. All members of the drilling crew must be trained for work at hazardous sites in accordance with 29 CFR 1910, including a 40-hour Health and Safety Training course. Health and Safety Training certification must be made available to the site hydrogeologist prior to the start of drilling operations.

The drilling sites are adjacent to an active landfill. High concentrations (up to 50% methane) of landfill gas have been known to be present in the subsurface and every precaution must be made to minimize the hazards presented by the presence of the gas. Every effort shall be made to reduce the potential to create a spark which could ignite the landfill gases. The Contractor will be responsible for creating a well-aerated work area. All members of the drilling crew must have an air-purifying respirator available at all times during the drilling operation. The Contractor must specify in writing, prior to mobilization, the provisions to be used for abatement of hazards due to methane encountered during the drilling operation, particularly during the welding of drive casing. No smoking will be allowed within 50 feet of the drilling rig.

4.16 Period of Performance and Schedule of Operation

The period of performance shall begin with the date of the fully executed contract and extend until the work is completed to the satisfaction of the site hydrogeologist and site representatives of the Snohomish County Department of Public Works. It is anticipated the Contractor shall begin the work on site the week of December 12, 1991.

A normal work day shall consist of 8 to 10 hours. During the Work, the Contractor may need to work longer days at the request of the site hydrogeologist but the length of a day will not be greater than 12 hours.

5. DRILLING

5.1 General

The extraction well to be installed as described in this scope of work will be used to re-establish interception of leachate-impacted groundwater at the Cathcart Landfill in Snohomish, Washington. Leachate impacted groundwater has been flowing downgradient from Cathcart Landfill to the north storm water detention pond for some time. An extraction well, W-1, previously removed groundwater at a rate of approximately 30 gallons per minute. However, recent improvements to the detention pond resulted in a drop in level pool elevation from 208 feet mean sea level (ft. msl.) to approximately 194 ft. msl. As a result, the groundwater elevation in extraction well W-1 dropped to a level that effectively eliminates W-1 as a viable extraction well and necessitating the installation of a new groundwater extraction system.

The new groundwater extraction system will consist of two new wells, one of which will replace W-1 and will be designated W-2. The second well will be a monitoring well, designated G-7, but the design will be similar to that of well W-2 so that it could service as an extraction well during times of high groundwater flow, or if the new extraction well is not capable of removing sufficient volumes of water by itself. Both wells will be installed in 10-inch diameter boreholes drilled in accordance with the procedures outlined in Section 5.2. Upon reaching the desired depth (approximately 13 feet below the bedrock surface), the wells will be constructed with stainless steel screens and carbon steel riser casing in accordance with Sections 6 and 7 of this scope of work.

Based on previous investigations at the site the anticipated geology that will be intercepted by the drilling operation appears to consist of silts, sands and gravels overlying a soft sandstone bedrock. A recent geophysical survey of the south end of the detention pond suggests a bedrock surface at an elevations ranging from approximately 220 ft. msl. to a low of approximately 188 ft. msl. in what appears to be a narrow bedrock channel. The proposed extraction well, W-2, is to be placed within the channel in order to take advantage of the increased saturated thickness above the bedrock contact. The second borehole, for monitoring well G-7, will be placed approximately 60 feet further to the west from the extraction well. Contact with the bedrock should occur at this location at an elevation of approximately 195 ft. msl. The water table is expected at an elevation of approximately 190 to 194 feet.

5.2 Air Rotary Drilling

An air rotary drilling rig shall be used to drill the extraction well and monitoring/extraction well boreholes. The boreholes will be drilled using a tricone drilling bit and 10-inch diameter steel conductor casing which will be driven to the desired depth. The rig must be equipped with a casing hammer.

- Steel casing may be set to create an open stable borehole down to the total depth of the borehole, if required. It is anticipated that the steel conductor casing shall be driven to the top of the bedrock surface, with any further drilling performed under open-hole conditions. The steel casing shall be capable of being withdrawn as the well is being constructed. Due to the potential hazards presented by landfill gases, the use of flush-threaded steel casing would be preferred. If welded casing is to be used, the Contractor must take every precaution to minimize the potential for igniting landfill gases. The casing shall be welded on a triple pass and lags or star welds will be placed over the joint at a minimum of three locations to increase the strength of the joint.

- The compressor shall deliver sufficient volume and pressure of air to create up hole velocities of at least three ft per second. The air from the compressor shall be filtered to insure oil from the compressor is not introduced into the borehole. The filters on air compressors shall be new and capable of providing the equivalent of Class D air.

- The drill rods shall have a minimum inside diameter of 1.375 in.

- The rotation speeds and drill advance rate shall be low enough that cuttings are blown from the borehole and do not clog the casing.

- Samples of drill cuttings shall be collected at a minimum interval of every 5 feet drilled. Split-spoon drive samples shall be collected by the drilling crew if so directed by the site hydrogeologist. The drive samples shall be collected in order to pinpoint the depth of the bedrock surface.

- Only approved lubricants (vegetable oil or Teflon-based grease) will be used for all downhole equipment to prevent the introduction of petroleum hydrocarbons into the borehole.

5.3 Air Rotary Sampling

Grab sampling for stratigraphic interpretation will be collected at a minimum of five foot intervals from the surface to the final depth of the borehole. The return circulation from the rotary rig will be channeled through a flexible hole and into a cyclone to facilitate the collection of samples and to ease the containment of the cuttings. At selected intervals, determined by the site hydrogeologist, penetration of the bit shall stop for such time as is required for all cuttings to move from the last drilled section before taking a sample.

Additional split-spoon samples may be collected at the direction of the hydrogeologist in order to determine the exact depth of the bedrock surface. Split-spoon (2.5- to 3-inch I.D. stainless steel split spoon sampler) samples will be collected at 2.5-foot depth intervals in the extraction well borehole starting at an elevation of 195 ft. msl. (depth approximately 43

ft.). The samples shall be representative of the in-situ soils or rock. Core from the split spoon sampler must be immediately extracted by the Contractor for collection and logging by the site hydrogeologist. Sample containers for all samples will be provided by the site hydrogeologist.

5.4 Drill Cuttings and Waste Water

Drill cuttings are produced as the drill bit of the drilling rig advances the borehole. The soil through which the bit cuts is displaced by the action of the rotating bit and transported to the ground surface within a circulating column of forced air. Air rotary drilling methods also produce waste water either through the injection of small amounts of water for the purpose of cooling the bit and reducing dust, or through the displacement of native ground water once the drill bit intercepts the water table.

Return circulation from the air rotary rig will be channeled through a flexible hose and cyclone for collection of the drill cuttings and waste water. Cuttings and waste water will be contained in Department of Transportation-approved 55-gallon drums, or other containers which have been approved by the site hydrogeologist. If airborne dust is visible, the return air and cuttings will be misted with a clean source of water to reduce the dust. Clean water may also be injected into the borehole to assist in the removal of drill cuttings. Drill cuttings and waste water contained during the drilling process will be disposed of on the landfill at the direction of the site hydrogeologist.

5.5 Decontamination

Contractor's personnel shall clean the Contractor's equipment to the hydrogeologist's satisfaction at a decontamination station provided to the Contractor. All down-hole equipment (drive casing, drill bits, samplers, drill rods, pumps and water level indicators) shall be thoroughly cleaned upon arrival at the site and between boreholes with a high-pressure, high temperature, jetted stream of water or steam. The Contractor shall supply an operational steam cleaner. The water for steam cleaning must be from an approved source. Only approved drilling lubricants (vegetable oil or Teflon grease) will be used for all downhole equipment to prevent the introduction of petroleum hydrocarbons into the borehole. Soils and decontamination water produced during the decontamination process shall be contained on plastic sheeting placed below the drill rig or tools to be decontaminated. All contained water and soils produced during the decontamination process shall be disposed of on the landfill at the direction of the site hydrogeologist.

6. EXTRACTION WELL AND MONITORING WELL CONSTRUCTION MATERIALS

This section stipulates the extraction well and monitoring/extraction well construction materials including well screens, riser pipe, well protector, filter material, grout mix, and water. All materials used in construction shall be free of chemicals, paint, coatings, etc., that could leach into the surrounding groundwater. It is the Contractor's responsibility to supply all equipment and materials needed to drill the boreholes and place the specified materials in accordance with these specifications.

6.1 Well Casings and Screens

The monitoring well will be completed using 6-inch diameter stainless steel screen welded to 6-inch diameter carbon steel riser casing. All casing and screen shall be supplied by the Contractor. The stainless steel screen will be provided by the Contractor in individually-wrapped 15-foot lengths and will be protected from exposure to potential contaminants at all times. The screen will have a slot size of 0.020-inches. A three-foot long section of 6-inch diameter stainless steel casing shall be attached to the bottom of the screen to provide the well with a sediment sump. The end of the sump will be fitted with a permanently-attached end plug. The screen section shall be welded to the sump casing section and the carbon steel riser casing. No welding rods containing lead compounds shall be allowed when attaching the screen to the riser or between sections of riser casing. Glued or riveted joints of any kind will not be allowed. The use of flush-threaded casing and screen may be proposed by the Contractor. However, all threaded joints must be fitted with o-ring seals to prevent leakage.

All well screens and casing shall be decontaminated in accordance with procedures outlined in Section 5.5.

6.2 Filter Pack Material

The filter sand shall consist of Colorado Silica Sand size 8/12, or equivalent approved by the site hydrogeologist which is free of silt, carbonate material, clay, or any other foreign material and that has a maximum 2% passing through the 0.020-in. slots of the stainless steel screen.

6.3 Grout Mix

- Cement. Cement shall be Portland Cement^{R} Type I in conformance with ASTM C 150. The cement shall be delivered to the job site in 94 lb sacks. The use of quick setting cements is prohibited unless authorized by the site hydrogeologist.

- Water. Water shall be obtained from the source designated by the site hydrogeologist.

- Bentonite. Bentonite shall be powdered sodium bentonite furnished in sacks without additives (Goldseal, or equivalent).

- Proportions. Cement shall be mixed with water in the proportions of five to six gallons of water per sack of cement. Between two and four pounds of bentonite powder shall be added to the mix for each sack of cement used. Add extra water in the ratio of up to 0.7 gallons of water per pound of added bentonite.

- Mixing. The grout shall be thoroughly mixed with a paddle type mechanical mixer or by circulating the mix through a pump until all lumps are removed. Grout which is lumpy shall be rejected.

- Grouting Procedure. Grout shall be injected into the borehole using a side-discharge tremie pipe placed immediately above the seal. Grout injection shall continue until clean grout flows out the top of the borehole. The monitoring well shall not be disturbed for at least 24 hrs. after grouting to allow the grout to set up.

6.4 Bentonite Pellets/Chips for Seals

Bentonite pellets shall be compressed dry pellets that are factory manufactured for use as a borehole seal or preferably screened bentonite chips such as Holeplug, or equivalent. The pellets/chips shall be 3/8- or 1/2-inch in diameter and shall be expandable with the addition of moisture. Preference shall be given to the use of bentonite chips for the borehole seals.

6.5 Health and Safety Equipment

The drilling crew shall be required to wear gloves, hard hats, protective eye glasses, and steel-toed boots. Due to the presence of methane gas at the landfill, all personnel associated with the drilling operation must have half-face air-purifying respirators available at all times.

7. WELL SCREEN AND RISER INSTALLATION

7.1 General

This section covers the placement of the well screens, filter material, seal, and annular grout in a borehole. This section includes removal of the temporary casing and installation of protective monument.

- Stable Borehole. A stable borehole will be constructed prior to attempting to install the extraction well or monitoring/extraction well. Boreholes which are not plumb or are partially obstructed shall be corrected prior to attempting the installation of the well. Jetting or driving the screen shall not be permitted.

- Sequence. The sequence of operations described herein shall be adhered to unless a specific agreement is made with the site hydrogeologist.

7.2 Assembly of Well Screen and Riser

- Handling. The workmen shall take precautions to assure that grease, oil, or other contaminants do not contact the screen. While handling the well screen, workmen shall wear a new pair of gloves. The riser and well screen provided will be steam-cleaned to the satisfaction of the site hydrogeologist prior to installation in the borehole.

- Centralizers. Two stainless steel centralizers shall be installed on each of the wells. The first centralizer shall be installed at the bottom of the sump, while the second is installed approximately 40 feet further up the casing to insure placement of the screen and casing in the center of the borehole. The site hydrogeologist shall designate the spacing of the centralizers. Stainless steel centralizers shall be supplied by the Contractor.

7.3 Placement of the Well Screen

Each well screen shall be positioned so as to have a high probability of intercepting the relatively thin saturated zone overlying the bedrock surface. The current design for the extraction well and the monitoring/extraction well consists of a screened interval from 5 feet above to 10 feet below the bedrock surface. This well design outlined below is schematically represented in Figure 2.

The well screen and riser shall be lowered to the predetermined level and held in position by suspending the string of riser pipe or, if the string tends to float, by manipulating the rig hydraulic ram. Even with the centralizers in place. The riser shall extend above the

ground at least three ft. The riser shall be trimmed to the proper length after the grout is in place. A slip cap or other closure device will be placed over the open end of the riser pipe during all well construction operations.

7.4 Placement of the Filter Material

- Volume of Filter Material. The volume of filter material required to fill the annular space between the well screen and the borehole walls will be calculated and carefully measured out. The filter pack shall extend a minimum of 3 ft above the uppermost row of slots in the well screen.

- Filter Placement. As sand is added to the annular space, the temporary casing, shall be periodically raised out of the hole. Sand shall not be allowed to accumulate inside the casing to a depth greater than 2 ft before the casing is raised, in order to prevent locking of the casing and the monitoring well casing/screen. Sand shall be placed carefully to insure that bridging does not occur. The top of the sand shall be measured with a weighted engineering tape periodically as it is placed to confirm proper placement of filter pack.

7.5 Placement of the Seal

- Volume of Seal Material. The volume of bentonite chips required to fill the annular space between the well casing and the borehole walls will be calculated and carefully measured out. The bentonite chip seal shall extend a minimum of 3 to 4 feet above the top of the filter pack.

- Seal Material Placement. As the bentonite chips are added to the annular space, the temporary casing shall be periodically raised out of the hole. Great care must be taken to prevent bridging which could lock the well casing and the temporary casing in place. The top of the seal shall be measured with a weighted engineering tape periodically as it is placed to confirm proper placement of bentonite seal. If the bentonite seal is constructed above the water table, at least five gallons of approved water per sack of bentonite chips shall be added to the borehole. In this case, placement of grout into the borehole shall not take place for at least 30 minutes following the addition of the water. Alternatively, a heavy bentonite slurry may be carefully tremied into the annular space to form the required seal.

7.6 Grouting the Annular Space

- Volume of Grout. The volume of grout required to completely fill the annular space between the seal and the ground surface shall be prepared in

the proportions specified in Section 6.3. The volume shall include a quantity to compensate for losses. The end of the tremie pipe shall be equipped with a deflection plate to prevent displacement of the filter pack and bentonite seal materials.

- Injection Procedures. The grout shall be injected via a side discharge tremie pipe, the opening for which is temporarily set immediately above the seal. The grout shall be pumped into the tremie pipe continuously until it reaches the ground surface.

- Temporary Casing Removal. The temporary casing will be removed immediately and in advance of the time when the grout begins to set. Temporary casing removal and injection may proceed concurrently provided the top of the column of grout is maintained at least 20 ft above the bottom of the casing and provided injection is not interrupted. If the casing removal does not commence until grout injection is completed, then additional grout shall be periodically poured into the annular space to maintain a continuous column of grout up to the ground surface.

- Grout Setting and Curing. The riser pipe shall not be disturbed for at least 24 hours after grouting is completed except for water level measurements made with an electronic water level indicator. Precautions shall be taken to prevent PVC pipe cuttings from entering the riser during trimming.

7.7 Wellhead Completion

The well will be completed below the ground surface in order to protect it and any vulnerable pump equipment, and water distribution piping from potential damage due to encounters with equipment used for normal landfilling operations at the site and to prevent water in the pipes from freezing during the winter months. A schematic drawing of the desired wellhead protection structure is provided in Figure 2. Although a specific design criteria is not presented within this work scope, the basic components of the structure should consist of a square concrete box similar in design to those used by utility companies for accessing subsurface valves, conduits, etc. (i.e. precast traffic box). It should be large enough to contain the well stickup, pump control box and ancillary equipment, discharge piping, flow meter, and check valve, with room enough to allow easy access to these components should they need to be replaced. Walls of the structure should have a minimum thickness of four inches. The bottom of the structure should consist of a minimum four-inch thick slab resting on approximately six inches of gravel backfill for drainage. The depth of the structure should allow for the stickup of the well (approximately 0.5 to 1 foot above floor slab) and the two foot minimum depth of the discharge pipe emanating from the pump. The structure should be equipped with a drain system capable of keeping the top of the well, as well as the electrical components of the pumping system, well clear of any standing water in the structure. The structure must be equipped with a lockable manhole cover, or equivalent.

8. WELL DEVELOPMENT AND ACCEPTANCE

8.1 General

This section covers the purging and development of the newly constructed extraction well and monitoring/extraction well. All wells shall be pumped with an acceptable submersible pump, or evacuated using filtered compressed air or nitrogen to produce representative formation water. The contractor shall also provide assistance to the hydrogeologist in determining the quantity of water ("yield") produced by the well during the development process. All pumps, tubing, surge blocks, etc., used during the development process will be decontaminated prior to use in accordance with procedures outlined in Section 5.5. Also described is the acceptance criteria for a completed well. All groundwater produced during the development of each well will be contained in 55-gallon drums, or other suitable containers, and stored until disposed of on the landfill. Development method options are as follows:

- Submersible Pumps. Submersible pumps shall include electric motor powered centrifugal or positive displacement pumps which are operated under submergence. If a submersible pump is used for well development, it shall be of the type and capacity such that it can pump water from the well continuously for a period of at least fifteen minutes without shutting off. Backpressure or other methods may be used to accomplish the desired rate of pumping. The pump shall be capable of being turned off and on instantly and repeatedly to create surges in the well. The pump shall not be fitted with a check valve.

- Bailers. Bailers are a less preferred method of developing the well and generally, should only be used for development after a pump or air lifting techniques have been tried and found to be ineffective due to the slow rate of water level recovery.

- Air Lifting. Compressed air supplied by an engine driven compressor equipped with an approved oil trap may be used. Bottled nitrogen or air may be used if the system is governed by a regulator. The air lifting system must be capable of evacuating 50 percent of the column of water from the well once every minute.

8.2 Periods of Well Development

Well development will be continued until representative formation water free of the effects of well construction is obtained, as determined by the hydrogeologist who will continuously monitor field chemical and physical parameters such as specific conductivity, pH, and temperature.

8.3 Well Acceptance

The well will be accepted by the site hydrogeologist when construction and development has been completed in accordance with these specifications.

9. EXTRACTION WELL PUMPING SYSTEM

9.1 Pumping System Components & Ancillary Components

The groundwater extraction system will consist primarily of the following components:

- Submersible Pump. The submersible pump must be capable of pumping up to approximately 30 gallons per minute (gpm). We are currently recommending the Grundfos 25S07-5, or the Gould 18E07412, or a suitable equivalent which must be approved by the site hydrogeologist and the Owner. The pump will require a 230V power source, supplied by the Owner.

- Discharge Pipe. Discharge pipe must match the discharge size and thread-type of the selected pump. Discharge pipe may consist of steel piping, or a suitable alternative of similar strength and durability.

- Fluid Level Control System. The fluid level control system is designed to control the operation of the pump based on the water level in the well. The system should include a high-water level probe to indicate the water level at which the pump will be turned on, a low-water level probe which will turn the pump off at a specified water level, and a ground probe. Fluid level control systems are available from several commercial manufacturers, including Warrick Controls, and Diversified Well Products.

- Pump Shield. In order to prevent the direct introduction of sediment into the pump, a pump shield will need to be fashioned around the pump housing (see Figure 2). The shield should have a minimum inside diameter of 4.5-inches in order to allow for adequate flow to the pump intake. It should consist of a section of thin steel or PVC pipe long enough to extend a minimum of 1.5 feet above and two feet below the pump and be open at the lower end to allow groundwater to flow into the pump from below the intake. In theory, any sand flowing into the well should drop out of the water column and into the well sump before it can flow to the pump, thus minimize long-term damage to the pump impellers. The shield should be open at the top as long as it extends above static water level. The shield should be attached directly to the pump discharge pipe with provisions made for attachment of the pump power leads and the water level probe access tube.

- Water Level Probe Access Port. Access to the well for water level measurements shall be through a 3/4-inch diameter, flush-threaded, PVC pipe extending from the top of the well to approximately one foot below the current static water level. The pipe should be attached directly to the pump discharge pipe and have a threaded cap at the top for easy access.

The top of the well must have a cap welded in place which contains leakproof access for the discharge pipe, power leads, fluid level control probes, and the water level probe access port.

9.2 Installation Specifications

The pump shall be installed in such a manner that the top of the pump is resting at an elevation of 185 ft. msl., or about seven feet below the expected static water level. This should place the pump intake at an elevation of approximately 184 ft. msl. Fluid level control probes shall be set in such a manner that the pump cycles off when the water level drops to an elevation of 186 ft. msl. and cycles back on when the water level recovers to an elevation of approximately 188 ft. msl. The pump will require a 230 volt power source. The pump control box and fluid level control module must fit neatly and in an easily accessible position inside the concrete wellhead structure.

10. PUMP DISCHARGE AND DISTRIBUTION SYSTEM

The groundwater pumped from extraction well W-2 will ultimately be discharged into the site leachate treatment system. The discharge pipeline from W-2 will be tied into the existing discharge system emanating from extraction well W-1, which leads to Flow Meter Vault C-FV-1 and Sump SP-1 (Figure 3). All distribution piping must be installed a minimum of 3 feet below grade and sloped to drain.

The discharge and distribution system will consist of the following components:

- Discharge Pipe. The portion of the discharge pipe emanating from the top of the well shall be the same diameter as the pump discharge within the well (presumably 1.25-inch). After passing into the flow meter and check valve, the discharge pipe shall be expanded to a diameter of 2-inches prior to connection with the distribution piping at a minimum depth of three feet below grade.

- Flow Meter. A flow meter will be attached to the discharge pipe to measure accumulative volumes of groundwater pumped from the well. The flow meter must be installed in a manner that makes it reasonably easy to access and remove, should it require repair or replacement.

- Check Valve. A check valve shall be installed in the discharge pipe on the downstream side from the flow meter in order to prevent water from backflushing into the well. The check valve must be installed in a manner that makes it reasonably easy to access and remove, should it require repair or replacement.

- Distribution Pipe and Trenching. The pump discharge pipe shall be connected to the distribution pipe, which will carry the discharge to a union with the discharge pipeline emanating from well W-1. The distribution piping will consist of 2-inch diameter Schedule 80 PVC. The connection with the well W-1 pipeline (also 2-inch PVC) shall be through a PVC "T"-fitting installed in the pipeline near W-1, but before it enters the Meter Vault, C-FV-1. Another check valve shall be installed on the upstream end of the connection (toward W-1) to prevent backflushing into W-1. All subsurface piping must be installed in a trench with a minimum depth of 3 feet below grade.

The discharge pipe from the well will be attached to the accumulative flow meter after passing through a 90-degree bend (Figure 2). From the flow meter, discharge will pass through a brass-spring check valve (or equivalent) installed to prevent water from backflushing into the well,and into a 2-inch diameter section of pipe which will be coupled to the distribution piping. The discharge piping must exit the W-2 wellhead at a minimum depth of 3 feet and changes shall be made in the piping configuration to accommodate this requirement. A proposed configuration for the distribution piping system is shown in

Figure 3. The excavated trench shall be a minimum of three feet deep. Distribution piping will be installed on structural fill and covered with native materials. Any excess excavated materials shall be disposed of on the landfill.

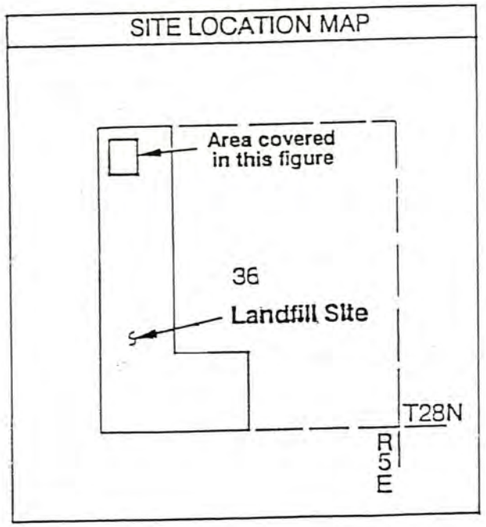
FIGURES

LEGEND:

- G-2 ● Monitoring well
- W-2 ◓ Proposed Extraction Well Location
- G-7 ◒ Proposed Monitoring/Extraction Well Location
- SP-4 ■ Sump SP-4
- Trench and Discharge Pipeline from W-2 to W-1 Discharge Line

G-2
SP-4
W-2
G-5
G-5A
Well W-1
(approximate location)
G-7
POND
206.2
G-6(S&D)
G-6A
G-6B
G-1A
PMAN
226.38
PMAO
255.35
244.4
244.3
246.2
216.1
248.8
246.9
245.9
246.1
247.
246.7
241.5
216.2
0
60 feet
SCALE

SITE LOCATION MAP



SOURCE: Base Map Adapted from Converse Consultants NW., 1988.

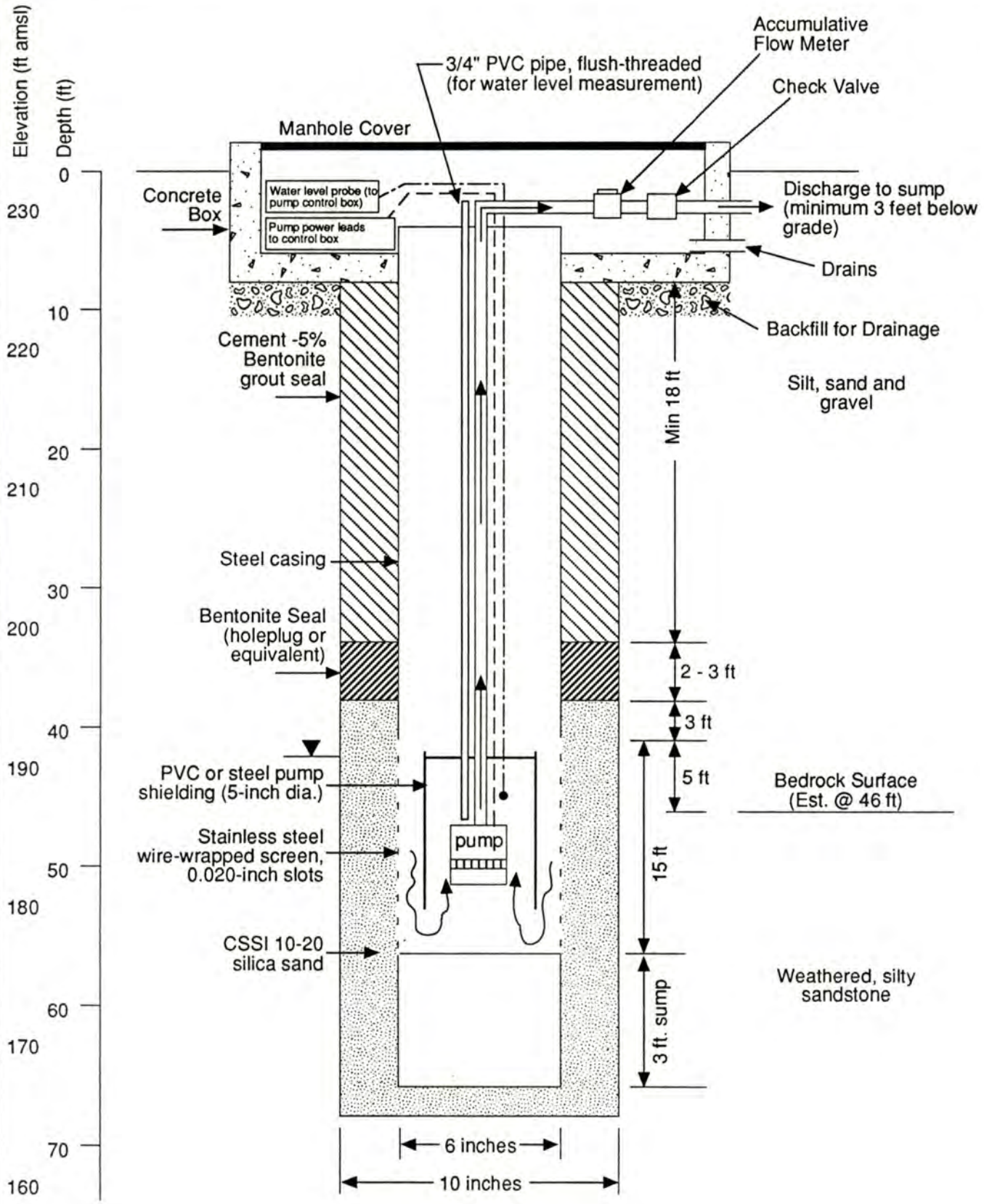
FIGURE 1

SITE OPERATIONS AND PROPOSED WELL LOCATIONS

SNOHOMISH/CATHCART WELL DESIGN/WA

PROJECT NO 913-1404 DWG NO 23727 DATE 11/25/91 DRAWN HP

Golder Associates



Not to scale

FIGURE **2**

SCHEMATIC DESIGN - EXTRACTION WELL

SNOHOMISH/CATHCART/WA

PROJECT NO. 913 1404 DRAWING NO. 27202 DATE 11/26/91 DRAWN BY EA

Golder Associates

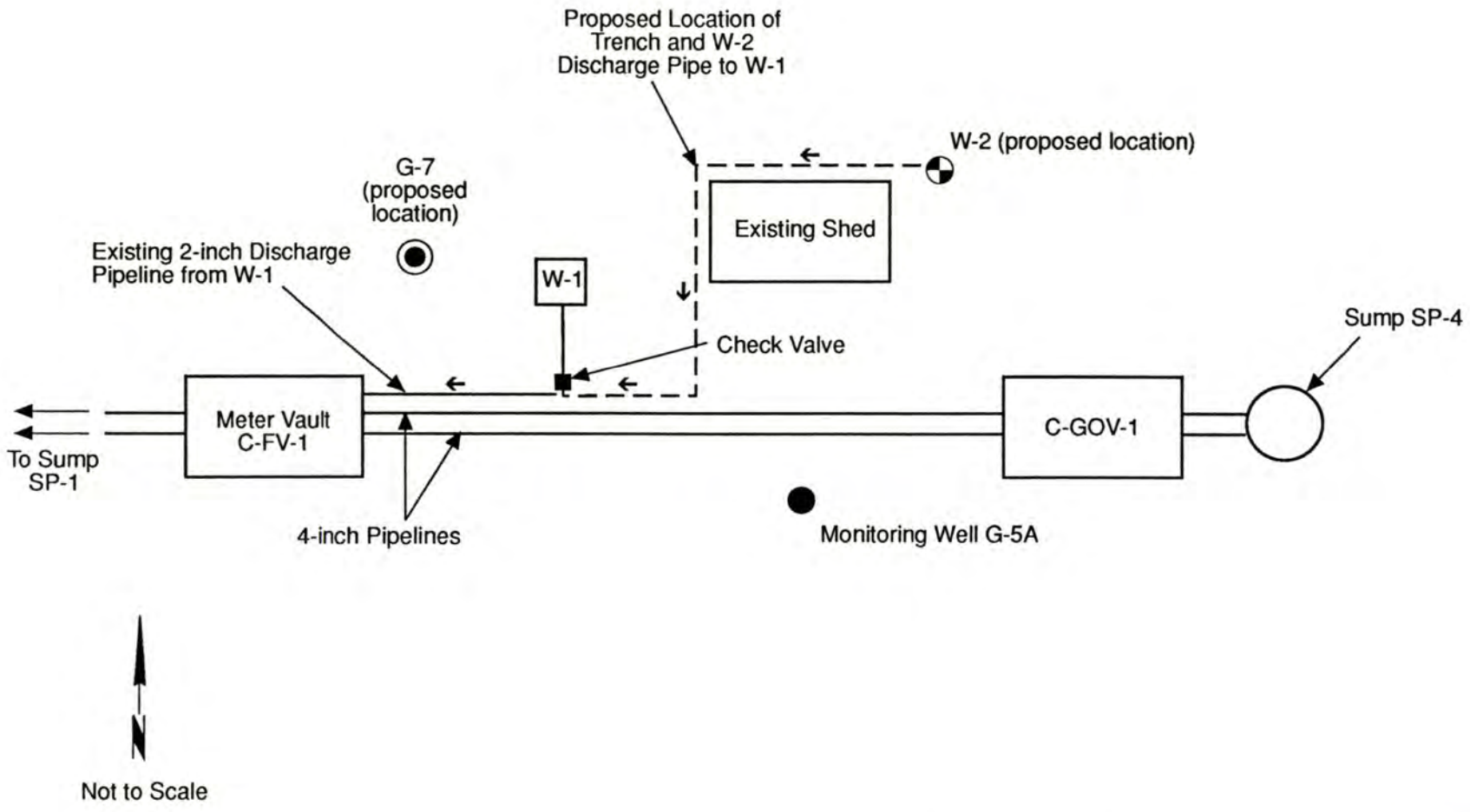


FIGURE **3**

SCHEMATIC DESIGN - EXISTING FACILITIES AND PROPOSED INSTALLATIONS

SNOHOMISH/CATHCART/WA

PROJECT NO. 913-1404 DRAWING NO. 29275 DATE 11/26/91 DRAWN BY JSS

Golder Associates

ATTACHMENT B
COST ESTIMATES FOR INSTALLATION OF A
GROUNDWATER EXTRACTION SYSTEM AND ASSOCIATED MONITORING WELL

Item	Units	Unit of Measurement	Price/Unit	Total
DRILLING & WELL INSTALLATION				
Mobilization/Demob.	1	Lump Sum	$4,000.00	$4,000.00
Decon.	3	Hour	$215.00	$645.00
Air Rotary Drilling, 10–inch diameter	110	Foot	$45.00	$4,950.00
Temporary Steel Casing, 10–inch diameter	80	Foot	$15.00	$1,200.00
Drive Shoe, 10–inch diameter	1	Each	$300.00	$300.00
Sampling, Split–spoon drive samples	5	Each	$85.00	$425.00
Moving	2	Hour	$145.00	$290.00
Standby	4	Hour	$215.00	$860.00
Borehole Abandonment	0	Hour	$250.00	$0.00
Per diem	5	Man/day	$50.00	$250.00
Steam Cleaner	3	Day	$120.00	$360.00
Water Truck	4	Day	$125.00	$500.00
Well Construction	10	Hour	$145.00	$1,450.00
Well Development (w/o rig)	4	Hour	$250.00	$1,000.00
Stainless Steel Screen, Wire–wrapped 15–Foot Sections, 0.020–inch slots	2	Each	$1,120.00	$2,240.00
Stainless Steel Casing, 6–inch (Sump)	6	Foot	40	$240.00
Stainless Steel End Plug	2	Each	25	$50.00
Carbon Steel Casing, 6–inch Diameter	90	Foot	$8.00	$720.00
Stainless Steel Centralizers, 6–inch	4	Each	$25.00	$100.00
Sand, CSSI 8/12	15	Bag	$12.00	$180.00
Bentonite Chips	8	Bag	$9.00	$72.00
Portland Cement, Type I	50	Bag	$12.00	$600.00
Bentonite Powder	2	Bag	$20.00	$40.00
Wellhead Structure (materials)	2	Each (estimate)	$500.00	$1,000.00
Labor (2–man crew installing Wellhead)	16	Manhour	$60.00	$960.00
			SUBTOTAL	$21,472.00
PUMPING SYSTEM				
Submersible Pump & Motor w/control box & power leads	1	Each	$600.00	$600.00
Discharge Pipe (galv. steel, 1.25", couplings	60	Foot	$3.00	$180.00
Fluid Level Control System (incl. control syst probes, probe wiring)	1	Unit	$250.00	$250.00
Pump Shield	1	Est. (fabricated)	$100.00	$100.00
Water Level Access Port (3/4" PVC flush–thread pipe)	60	Foot	$1.50	$90.00
Pump System Installation	3	Hour	$150.00	$450.00
			SUBTOTAL	$1,670.00
DISCHARGE SYSTEM				
Backhoe	1	Day	$600.00	$600.00
Installation Labor	10	Manhour	$60.00	$600.00
Discharge Piping, Elbows, Couplings	1	Lump Sum (est.)	$50.00	$50.00
Flow Meter	1	Each	$200.00	$200.00
Check Valve	2	Each	$50.00	$100.00
Distribution Pipe & Fittings (2" Sch. 80 PVC, Flush–Thread)	100	Foot	$4.00	$400.00
			SUBTOTAL	$1,950.00
			TOTAL	$25,092.00

Note:
Costs do not include on–site engineering time.