General

Los Alamos

Los Alamos National Laboratory
Los Alamos, New Mexico 87545

memorandum

TO: Distribution

FROM: Charles Nylander, ESH-18

DATE: September 22, 1999

MAIL STOP/TELEPHONE: K497/5-4681

SYMBOL: ESH-18/WQ&H:99-0381

SUBJECT: **EAG SEMI-ANNUAL MEETING AND HYDROGEOLOGIC CHARACTERIZATION PROGRAM QUARTERLY MEETING**

This letter is an invitation for you to participate in the Los Alamos National Laboratory Hydrogeologic Workplan External Advisory Group (EAG) Semi-Annual Meeting and the Hydrogeologic Characterization Program Quarterly Meeting. The combined meetings will be held on October 13-15, 1999 in Los Alamos. The EAG Semi-Annual Meeting will be on October 13 and 15 in the LATA 4th floor conference room in the Los Alamos National Bank Building at 1200 Trinity Dr, Los Alamos, New Mexico. The Hydrogeologic Characterization Program Quarterly Meeting will be held on October 14 at the Los Alamos Inn in Los Alamos.

The agenda is attached. The first day of the EAG Meeting, October 13, will include a performance review (EAG recommendation from October 1998) and topical presentations on technical aspects of the Hydrogeologic Characterization Program. The Quarterly Meeting, on October 14, begins with status updates on all aspects of the program (drilling, modeling, information management, hydrology, and geochemistry) and a discussion on the progress and direction of the program. The afternoon is reserved for stakeholder discussions with EAG members on any groundwater-related concerns, without the presence of LANL personnel. The final day of the EAG meeting, October 15, is reserved for EAG members to meet with DOE, LANL, and NMED management (EAG recommendation from March 1999). The afternoon of October 15 is reserved for EAG members to prepare their semi-annual report.

Your participation in the hydrogeologic characterization meetings is much appreciated and your continued involvement is important to the success of the program. I look forward to seeing you at the combined LANL EAG and Hydrogeologic Characterization Program Quarterly Meeting. If you have any questions, please do not hesitate to contact me at (505) 665-4681; or e-mail nylander@lanl.gov; or contact Kelly Bitner at (505) 884-8455; or bitner@neptuneandco.com.

CN/rm

Enclosures: a/s

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B. Jacobs, Bandelier, NM, w/enc.
R. Hull, LATA, MS M321, w/enc.
S. Johnson, LATA, MS M321, w/enc.
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J. Holt, NWT-PO, MS F629, w/enc.

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AGENDA
LOS ALAMOS NATIONAL LABORATORY
GROUNDWATER INTEGRATION TEAM (GIT)
AND EXTERNAL ADVISORY GROUP (EAG)
COMBINED MEETING
OCTOBER 13-15, 1999

October 13
EAG Meeting
LATA Conference Room, 4th Floor Los Alamos National Bank Building

9:00 Welcome and Overview of the Agenda (C. Nylander)
9:15 Action Plan for EAG March Report
10:15 Break
10:30 Performance Review for Hydrogeologic Workplan activities
12:00 Lunch
1:30 Topical Presentations

- Modeling
- DQO re-visitation results

4:30 Adjourn

October 14
GIT Quarterly Meeting
Los Alamos Inn, Los Alamos

8:00 Welcome and Introduction (C. Nylander)
8:15 GIT Subcommittee Status Reports

- Information Management (K. Mullen)
- Hydrology (D. Rogers)
- Geochemistry (P. Longmire)
- Modeling (B. Robinson)
- Well Construction (D. Broxton)

10:15 Break
10:30 Status of Field Activities (D. Broxton)

- R-25
- R-15
- R-9
- R-12

11:00 Issues (C. Nylander)

- Response to contamination
- Drilling schedule
- Lessons learned on R-25

12:00 Lunch
1:30 Stakeholders meet with EAG
3:30 EAG facilitate discussion of stakeholder concerns with GIT
5:00 Adjourn

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LOS ALAMOS NATIONAL LABORATORY
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COMBINED MEETING
OCTOBER 13-15, 1999

October 15
EAG Meeting
LATA Conference Room, 4th Floor Los Alamos National Bank Building

9:00 EAG meeting with DOE, LANL, and NMED Managers
11:00 EAG facilitate discussion of management concerns with GIT
12:00 Lunch
1:30 EAG report preparation

Los Alamos National Laboratory
GIT/NMED Data Collection DQO Review
September 13, 1999

Introduction

The Hydrogeologic Workplan was developed using the Data Quality Objective (DQO) Process. A critical part of the DQO process is the iteration of the DQO process outputs as new data are collected. Four boreholes have been drilled at LANL, and sufficient new information on data collection methods is available to iterate on the DQO outputs. Specifically, those outputs relating to collecting geologic, hydrologic, and geochemical data during drilling warranted review based on the costs incurred on the program to date. On September 13, 1999 the LANL Groundwater Integration Team (GIT) held a working meeting with NMED HRMB and DOE-OB to iterate on these DQO outputs.

Decisions and Questions

Figures 1- 10 graphically illustrate the determination of data needs by formulating decisions and subsidiary questions. In this pyramidal structure, the decision is at the top and the subsidiary questions that must be answered in order to resolve the decision are shown in the next row. At the very base of the pyramid are the data that will be required to answer the questions that will lead to final resolution of the decision.

The participants had only one suggested change, to Canyon Decision 5 (Figure 5) regarding the time period of interest. The original decision used 1000 years based on DOE requirements, but the point was made that the time period of interest will vary depending on the contaminant. Hazardous constituents could be considered subject to the RCRA post-closure care period of 30 years, where low-level radioactive waste has EPA guidance suggesting 1000 years is the appropriate period of interest. Transuranic and high-level waste constituents should meet the DOE guidelines for repositories of 10,000 years.

The period of interest can make a significant difference in the types and amount of data collected. The data that would be used to predict contaminant migration over 30 years, which approximately doubling the period the Lab has been in operation, is much different than data used to predict over 1000's of years. Although the data required for predicting 10,000 years is likely to be quite similar to data required to predict over a period of 1000 years, the jump from 30 years to 1000 years requires a substantial investment.

Although no consensus on the actual time frames was reached during the meeting, there was agreement that the time frames should be tailored for classes of contaminants.

Data Needs

The data that must be collected from the boreholes/wells was listed from the DQO outputs in the Hydrogeologic Workplan. The participants reviewed the list and made recommendations for additions and deletions. Consensus was reached before changes were made to the list. The final list is:

Data Collected from a Single Borehole/Well
Hydraulic properties
Water level
Moisture characteristics
Contaminant concentration
Porosity
Bulk density
Stratigraphy
Lithology
Kds
Fracture characteristics
Fault characteristics
Water quality
Matric potential

Data Collected from More than one borehole/well
Water balance
Vertical gradient
Horizontal gradient
Flow direction
Tracer tests
Flow velocity

There was discussion regarding the scope of data required to characterize fractures. For the modeling, the critical element is the permeability of the fractured zone, rather than detailed descriptions of fracture density, length, aperture, attitude. There was agreement that the data required for fractured zones is permeability.

Data Collection Methods

Table 1 summarizes the potential data collection methods, the advantages of the methods, the limitations of the methods, a relative rating of the resulting data quality and cost, and drilling requirements. There are only two types of data that can not be collected in a borehole drilled with mud methods – air permeability by rig balance and moisture characteristics measured in the cuttings. However, the process to collect samples in a fluid-filled borehole is generally more complicated than in a dry-drilled hole. The process involves introducing an upper and a lower packer into the borehole, sealing off an interval, circulating out the mud from the borehole, developing the interval to remove the mud cakes on the borehole sides, and collecting the sample. Additionally, input received after the meeting indicates that samples taken in boreholes where drilling mud is used (even in R-15, a nominally dry-drilled hole) has significant impacts on the analyses of water samples.

Drilling Methods

Table 2 is a comparison of drilling methods that was distributed at the meeting. The geologic conditions at LANL are such that in some parts of the stratigraphic section the borehole must be held open by physical means. The drilling methods that can be used at LANL include casing advance (in which the casing holds the borehole open) and mud rotary type methods (in which the drilling mud holds the borehole open). As indicated in Table 2, there are issues associated with each method, e.g. the expense of casing advance

and with the mud rotary methods, the potential for lost circulation and expense of disposal of contaminated drilling mud. There was general agreement that the drilling method for any well should be selected after careful review of the expected geologic conditions and data needs.

Conclusions

The major conclusions from the meeting were:

- Data needs listed in the Hydrogeologic Workplan, and revised during this meeting, are considered potential data to be collected. The actual data collected in each well will be based on the types of data needed from that geographic location and will be specified in the Field Implementation Plan.
- Data collected for "fracture characteristics" can be limited to permeability in the fractured zone.
- Most data types can be collected in boreholes drilled with either dry methods or fluid-based methods, although fluid-based methods require more complicated sampling process and have a significant impact on the chemistry of the water.
- Drilling methods that physically hold the borehole open are required for some portions of the stratigraphy underlying the Pajarito Plateau; casing advance or mud rotary-type methods are likely to be the most successful.
- The drilling method for each well should be selected based on the anticipated geologic conditions and the types of data needed from that well.
- The issue of the time frame of interest has not been conclusively resolved at this time and warrants further consideration.

Table 1: Data Collection Methods

Data Type	Data Collection Method	Advantages	Limitations	Relative Data Quality[1]	Relative Cost [2]	Drilling Method Requirements
Hydraulic Properties	Recovery/slug test during drilling	Inexpensive, does not significantly slow drilling	Need an open hole, and a clean hole	3	A	Open hole, dry or filled[3]
	Single packer test during drilling	Inexpensive, does not significantly slow drilling	Need an open hole, and a clean hole	3	A	Open hole, dr filled[3]
	Core Analysis	Easily done on intervals where core is available	Produces measurements of hydraulic properties on a small-scale	3	B	Open hole, dry or filled[3]
	Slug test – completed well	Standard method of measuring hydraulic properties	Limited to the screened interval of the completed well	4	B	Conducted in com well so drilling me does not matter
	Geophysical Logs	Vertically continuous	Requires an open hole; some logs are limited to fluid-filled hole	4	B	Open hole, dry or filled[3]
	Air permeability by rig balance	Continuous during drilling, large scale	Less quantitative, requires dry, open hole	2	A	Open hole, air dril
	Air permeability by packer test	More quantitative	Requires dry open hole	3	A	Open hole, dr filled[3]

[1] Rating is relative between collection methods for the same data type. The scale is 1 = low to 5=high.
[2] Rating is relative between collection methods for the same data type. The scale is A=inexpensive and B=expensive
[3] In fluid filled holes, the interval of interest must be isolated with packers and the mud circulated out of the interval before a test can be conducted.

Table 1: Data Collection Methods

Data Type	Data Collection Method	Advantages	Limitations	Relative Data Quality[1]	Relative Cost [2]	Drilling Method Requirements
	Pumping test in completed well	Large scale, provides best estimate of hydraulic properties	Need monitoring well nearby as an observation well	5	B	Conducted in com well so drilling me does not matter
Water Level	Transducer	Continuous data, good resolution	Requires open hole with no tools downhole; reliability is an issue	5	A	Open hole, d r filled[3]
	Probe/tape	Fast, can be used with tools in the hole	Single point measurements; resolution is an issue	3	A	Open hole, dry or filled[3]
Measurements on Rock (porosity, lithology, stratigraphy, bulk density, fracture characteristics)	Core analysis in a lab	Direct measurement	Requires core	5	B	Dry or fluid-filled, advances in front c mud, so core is no by mud
	Cuttings analysis in a lab	Direct measurement, cuttings always available		4	A	Dry or fluid-filled, although cuttings f drilled with mud n washed before test
	Geophysical logging	Continuous measurements	Indirect measurement, requires an open hole	4	B	Various logs e requirements fl filled or dry holes
Matric Potential and Kds	Core analysis in a lab	Direct measurement	Requires core	5	B	Dry or fluid-filled, advances in front c mud, so core is no by mud

Table 1: Data Collection Methods

Data Type	Data Collection Method	Advantages	Limitations	Relative Data Quality[1]	Relative Cost [2]	Drilling Method Requirements
	Cuttings analysis in a lab	Direct measurement, cuttings always available	Cuttings from hole drilled with mud must be washed before testing which could affect test results	4	A	Dry drilled hole
Moisture Characteristics	Core analysis in a lab	Direct measurement	Requires core	5	B	Dry or fluid-. .ed, advances in front c mud, so core is no by mud
	Cuttings analysis in a lab	Direct measurement, cuttings always available	Must come from a dry drilling method	4	A	Dry drilled hole
	Geophysical logging	Continuous measurements	Indirect measurement, requires an open hole	4	B	Various logs have requirements for fl filled or dry holes
Water Quality/ Contaminant Characterization	Lab analysis of water samples	Provides the best analytical results	Chemistry is effected by drilling fluids; long turn around time	5	B	Open hole, dry or filled[3]
	Field screening of water samples	Indication of presence/absence of contaminants, rapid turn around	Intended for contaminants, not water quality measurement; does not provide quantitative results	2	A	Open hole, d or filled[3]
	Field measurements of water samples	Rapid tests; necessary for sampling water		4	A	Open hole, dry or filled[3]

Table 2: Comparison of Drilling Methods

Drilling Method	Description	Good	Bad	LANL Considerations
Cable Tool	Drill bit is dropped and crushes the rock; crushed rock mixes with formation water or added water to form a slurry that is removed by a bailer or pump. Open hole method; requires casing driven closely after the drill bit to keep the hole open	Relatively inexpensive; Rigs are simple and require little maintenance; Borehole is stabilized during the entire drilling operation Recovery of reliable samples is possible except when heaving sands occur; Can be drilled in areas where little make-up water exists; Wells can be constructed with little chance of contamination; Rigs can be operated in more inaccessible terrain or where space is limited; Wells can be drilled where lost circulation is a problem;	Penetration rates are slow; difficult to pull back long strings of casing; May require more expensive heavy wall casing.	Too slow for the planned depth of holes; Not enough power to pull back for casing; Difficult to seal perched zones; More difficult to maintain hole alignment.
Direct Rotary	Rotating bit cuts the formation and cuttings are removed by fluid circulated down the drill pipe and out through ports in the drill	Penetration rates relatively high Minimal casing required during drilling	Limited to a diameter of 22-24 inches Intrusion of the drilling mud into the formation	Potential for loss of circulation in fractures (experienced at Sigma Mesa); Not possible to identify

Table 2: Comparison of Drilling Methods

Drilling Method	Description	Good	Bad	LANL Considerations
	bit. The fluid then flows up the annular space to the surface. During drilling the borehole is kept open by the drilling fluid.			thin perched zones during drilling; Allows cross contamination because the drilling fluid fills the entire borehole; Drilling fluids can become hazardous waste if contaminated water is encountered.
Reverse Circulation Rotary	Rotating bit cuts the formation. Cuttings are carried to the surface by fluid that moves down the annular space and up the drill pipe. The fluid is usually muddy water, not mud. To prevent caving of the hole, fluid level must be kept at ground level at all times.	Least expensive method for large-diameter holes in unconsolidated formations; Porosity and permeability near the borehole is relatively undisturbed; No casing is required during drilling; Little opportunity for wash-outs because of low velocity fluid	Large water supply needed; Large mud pits required; Rigs are large so access may be a concern;	Potential for loss of circulation in fractures (experienced at Sigma Mesa); Not possible to identify thin perched zones during drilling; Allows cross contamination because the drilling fluid fills the entire borehole; Drilling fluids can become hazardous waste if contaminated water is encountered.
In-Verse	Special equipment added to a top-head drive direct rotary rig to convert a direct rotary machine to a	Large diameter boreholes can be drilled; Penetration rates are high in unconsolidated		

Table 2: Comparison of Drilling Methods

Drilling Method	Description	Good	Bad	LANL Considerations
	reverse circulation rig. Cuttings and drilling fluid are assisted to the surface by airlift inside the drill pipe.	sediments; Less drilling fluid additives are required to lift cuttings		
Direct Rotary Air	Rotating bit cuts the formation. Air is forced down the drill pipe through small ports in the bit, lifting the cuttings and cooling the bit.	Cuttings removal is rapid; Aquifer is not plugged with drilling fluids; Estimate of yield can be made during drilling	Limited to semi-consolidated or consolidated formations;	Open hole – nothing to hold the hole open.
Down-the-Hole Air Hammer	A pneumatic drill operated at the end of the drill pipe rapidly strikes the rock while the drill pipe is slowly rotated. Cuttings are removed by the compressed air used to drive the hammer	Cuttings removal is rapid; Aquifer is not plugged with drilling fluids; Estimate of yield can be made during drilling Penetration rates are high in highly resistant rocks; Estimate of yield can be made during drilling	Limited to semi-consolidated or consolidated formations;	Open hole - nothing to hold the hole open; Not effective in hard rock (basalts)
Dual Wall Reverse Circulation Rotary	Double wall drill pipe with a rotating bit or a down-hole hammer. Air or water is forced down the annulus between the double walls to lift the cuttings through the center pipe.	Continuous representative formation and water samples can be obtained; Estimates of aquifer yield can be easily made at many depths; Fast penetration rates in course alluvial deposits or	System is limited to slim holes (<10 inches); Limited to 1400 ft in alluvial deposits and 2000 ft in hard rocks.	Although the hole is kept open during drilling, the drill string must be pulled out to construct well, nothing to hold the hole open

Table 2: Comparison of Drilling Methods

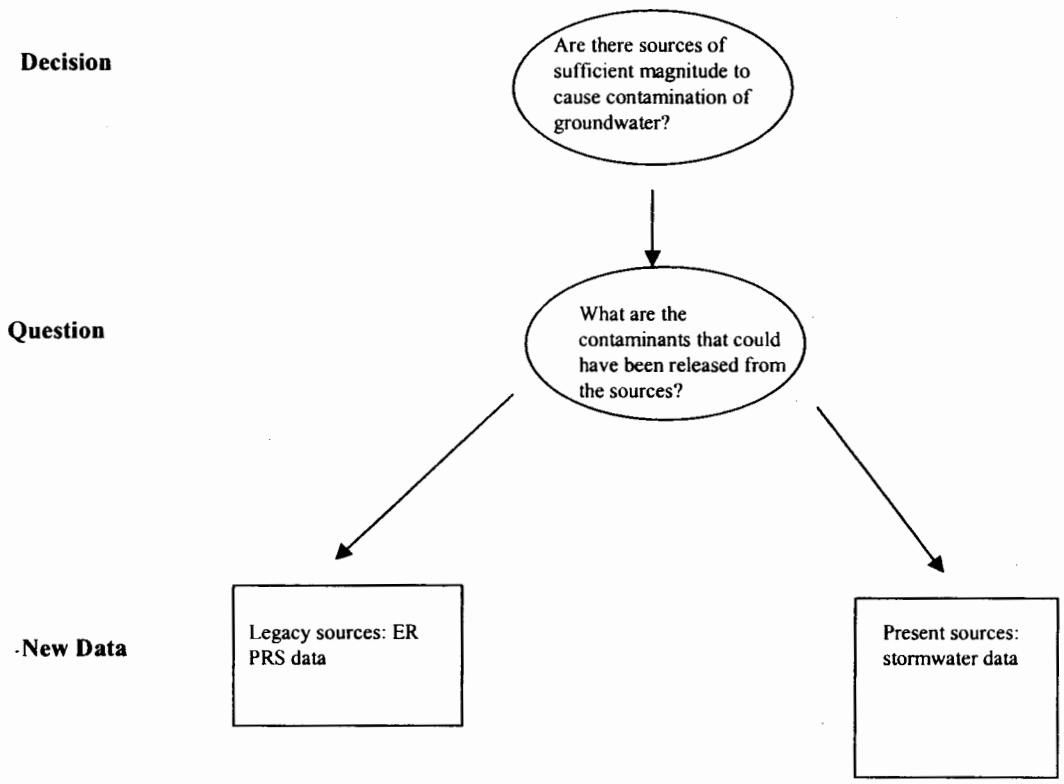
Drilling Method	Description	Good	Bad	LANL Considerations
		fractured rock; Problems with lost circulation and washouts are eliminated or reduced drastically.		
Drill-Through Casing Driver (aka ODEX-STRATEX; Barber rig)	Casing drive system consists of a bit and drill pipe fitted within a casing. The bit/drill pipe can drill ahead of the casing advance, at the same rate as the casing; or to drill out the plug when the casing is driven first. Cuttings are blown up the short open hole into the casing and pass out the top. Casing can be driven by hammer (ODEX-STRATEX) or by rotating the casing (Barber)	Particularly suitable for drilling in stratified deposits that have large differences in particle size; Wells can be drilled in unconsolidated geologic materials that may be difficult to drill with cable tool or direct rotary methods; Borehole is stabilized during the entire drilling operation; Rapid penetration rates; Lost circulation problems are eliminated; Accurate formation and water samples can be obtained; No water-based drilling fluids required in unconsolidated materials.	Cost; Noise.	Hammer –driven is slower at depth because of the energy lost in hammering on rock and casing shoe at same time;
Jet Drilling	Chisel-shaped bit attached to the lower end of a pipe	Used for small diameter wells in water bearing		Not appropriate for hard rock (basalts)

Table 2: Comparison of Drilling Methods				
Drilling Method	**Description**	**Good**	**Bad**	**LANL Considerations**
	string. The drill string is lifted and dropped similar to cable tool drilling, but with shorter strokes. Holes on each side of the bit serve as nozzles for water jets that keep the bit clean and help loosen the materials being drilled. The drilling water then flows upward in the annular space around the drill pipe carrying the cuttings in suspension. Casing, fitted with a drill shoe is normally sunk as drilling proceeds.	sands, but can also be used in semi-consolidated or consolidated formations that are not too hard.		
Hydraulic Percussion (aka hollow rod method)	Uses a string of drill pipe and a bit. A ball check valve is located between the bit and the lower end of the drill pipe. Water is introduced into the annular space between the drill pipes and the well casing to keep the hole full of water. Drilling is done by lifting and dropping the drill string. Water enters the	Minimum equipment requirements; Ability to obtain accurate samples	Limited to drilling small diameter wells through clay and sand with no cobbles or boulders.	Limited to small diameter wells; Not appropriate for basalts or coarse portions of the Puye; Open hole method—nothing to keep the borehole open.

Table 2: Comparison of Drilling Methods

Drilling Method	Description	Good	Bad	LANL Considerations
	ports of the bit and continuous reciprocating motion produces a pumping action to lift the fluid to the surface.			
Sonic	Inertially activated drill head which generates high-frequency sinusoidal vibrations in a drill string produces a cutting action at the bit face. Cuttings are forced into the walls of the borehole.	Yields continuous, relatively undisturbed core; Eliminates introduction of drilling fluids; High penetration rate.	Requires driller experienced in sonic drilling; Intense cyclic loads have led to destructive failure of certain system elements; High noise levels;	Creates tremendous amount of air particulates; Open hole – nothing to keep the hole open.
Auger Drilling	Screw-like drill rod that is either solid or hollow core. Drill cuttings are brought to the surface through screw action as the flights of drill rod are advanced. Typically used in soft rock or soil. Various diameters are available.	Successful in drilling test holes for foundation studies and shallow groundwater investigations. Rate of penetration is rapid and reliable samples can be taken at any depth. Use of wireline method yields continuous core.	Maximum depth is limited by geologic conditions. Difficult to use in basalt, cobbles, boulders, and hard tuffs. Application at LANL limited to alluvial wells and starter holes for regional wells for conductor casing and jack cellar.	

Figure 1: Canyons Decision 1



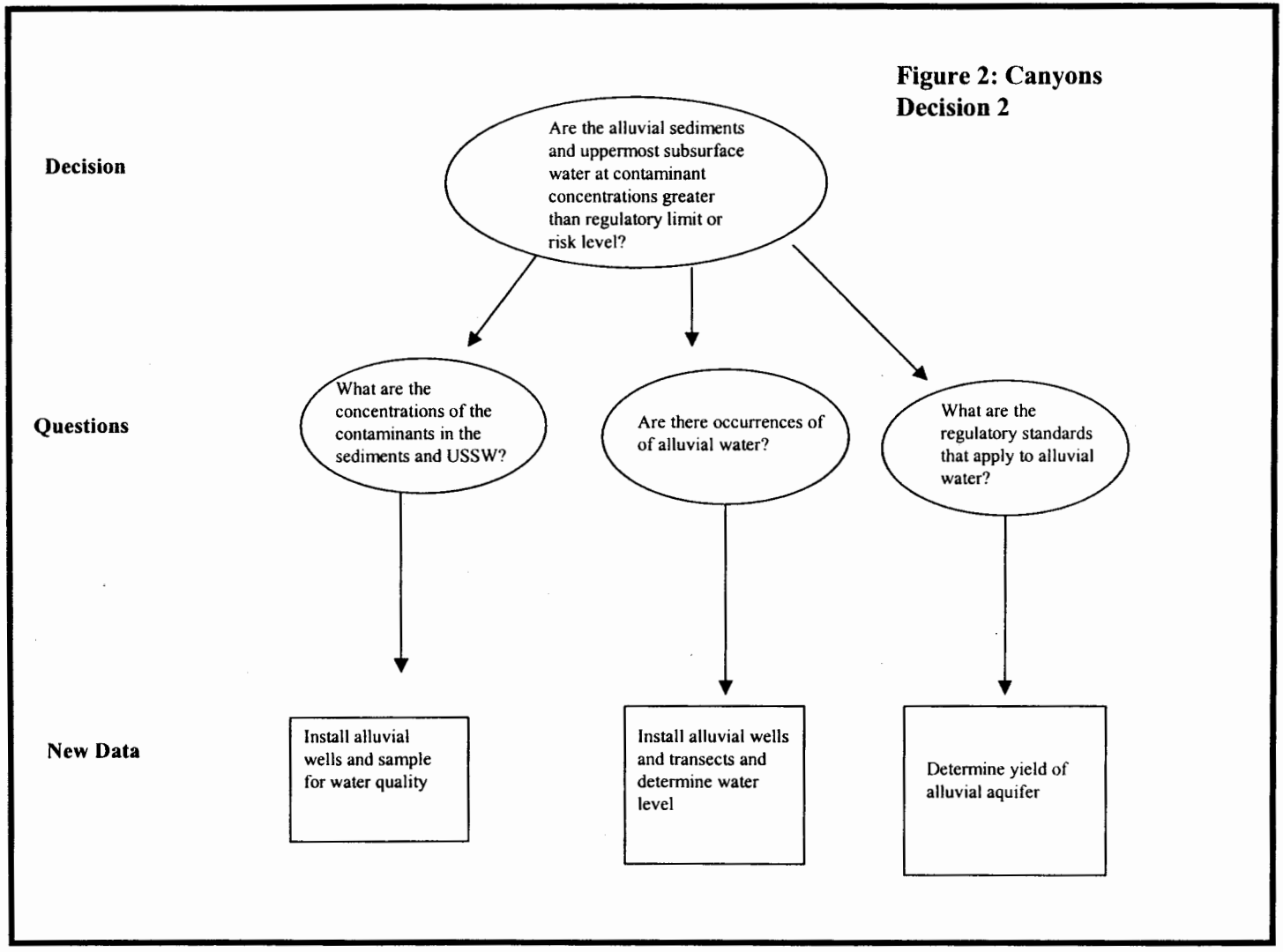


Figure 2: Canyons
Decision 2
Decision
Are the alluvial sediments and uppermost subsurface water at contaminant concentrations greater than regulatory limit or risk level?
Questions
What are the concentrations of the contaminants in the sediments and USSW?
Are there occurrences of of alluvial water?
What are the regulatory standards that apply to alluvial water?
New Data
Install alluvial wells and sample for water quality
Install alluvial wells and transects and determine water level
Determine yield of alluvial aquifer

Figure 3: Canyons Decision 3

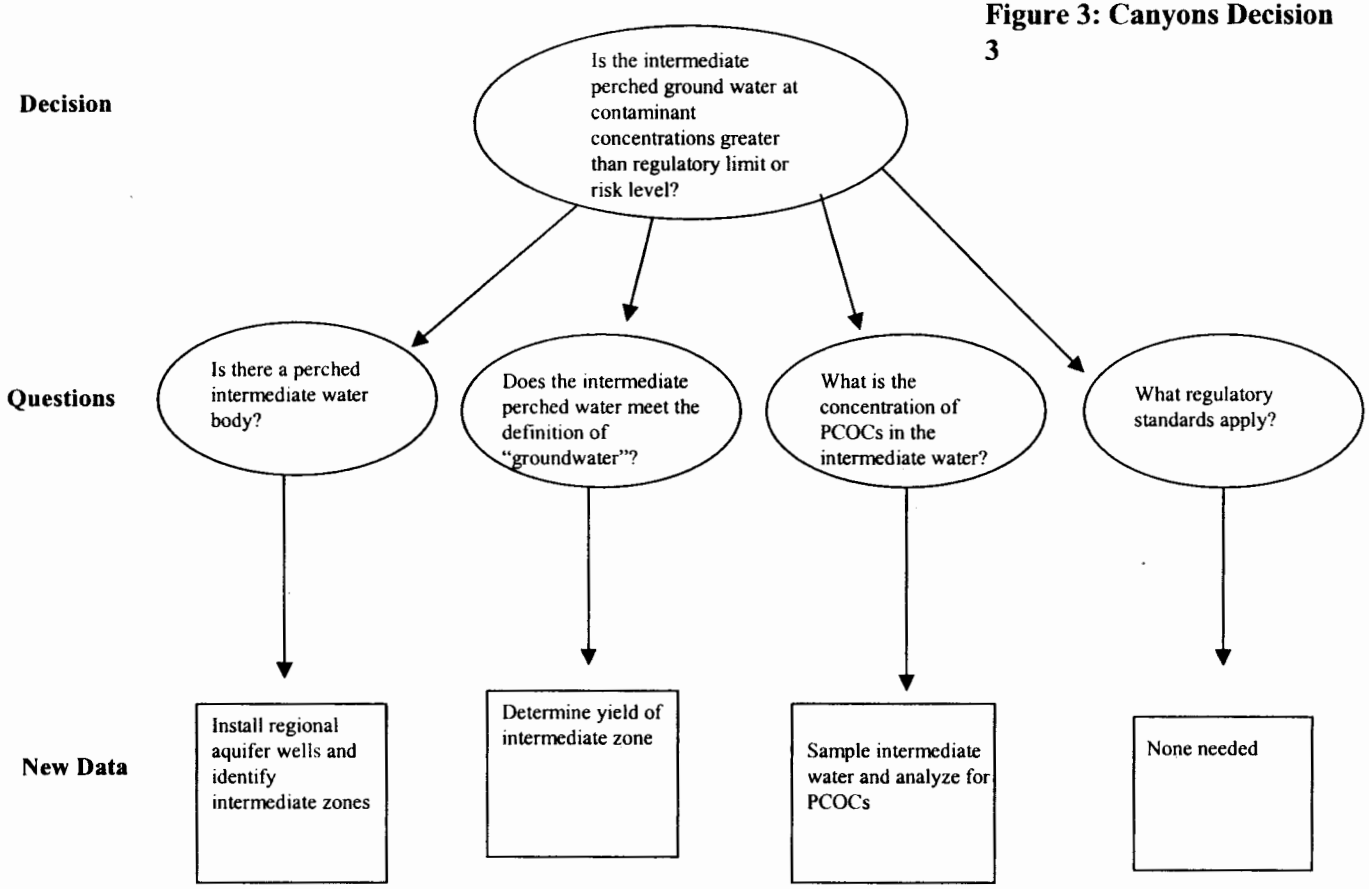


Figure 4: Canyons Decision 4

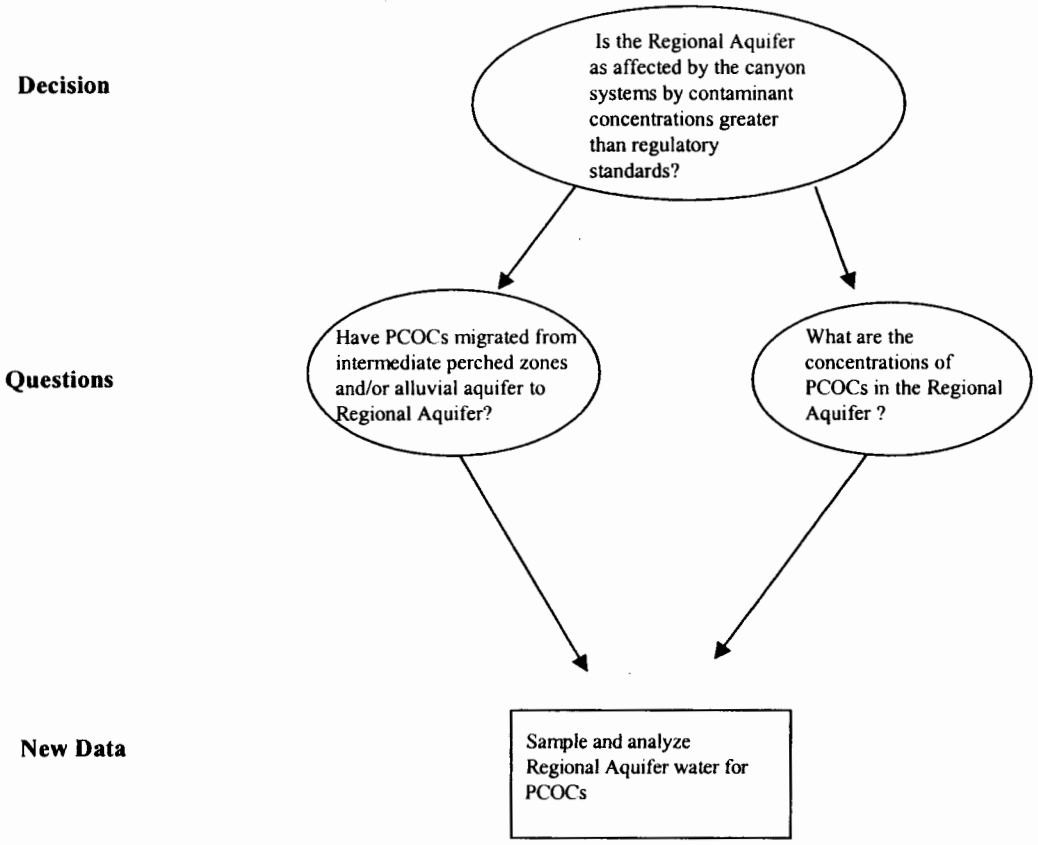


Figure 5: Canyons Decision 5

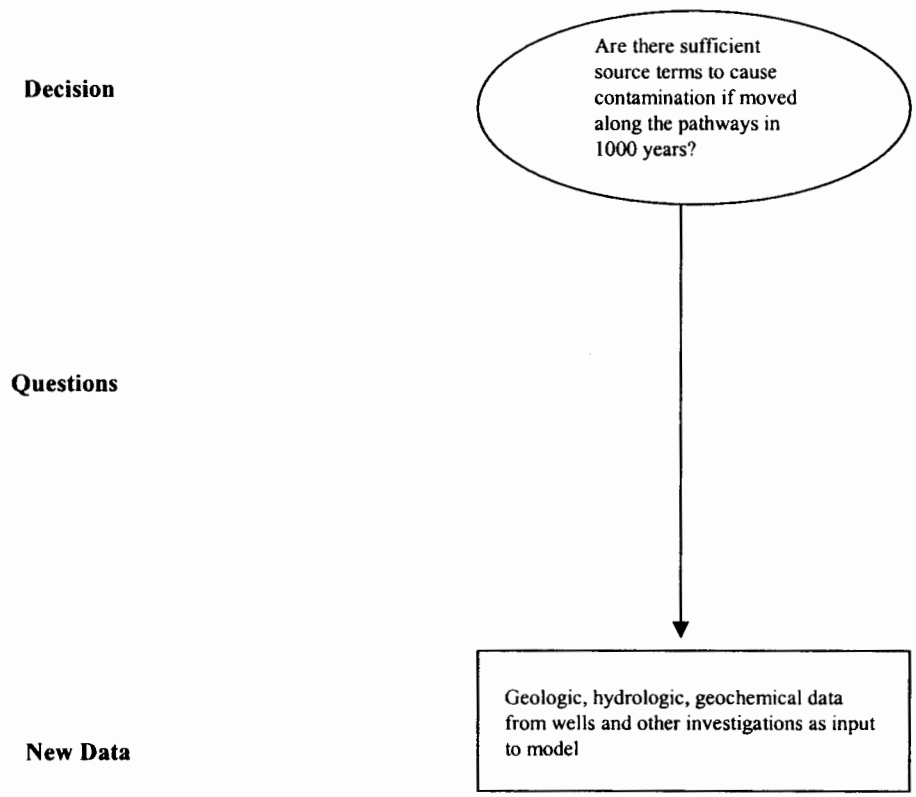


Figure 7: Mesa Decision 1

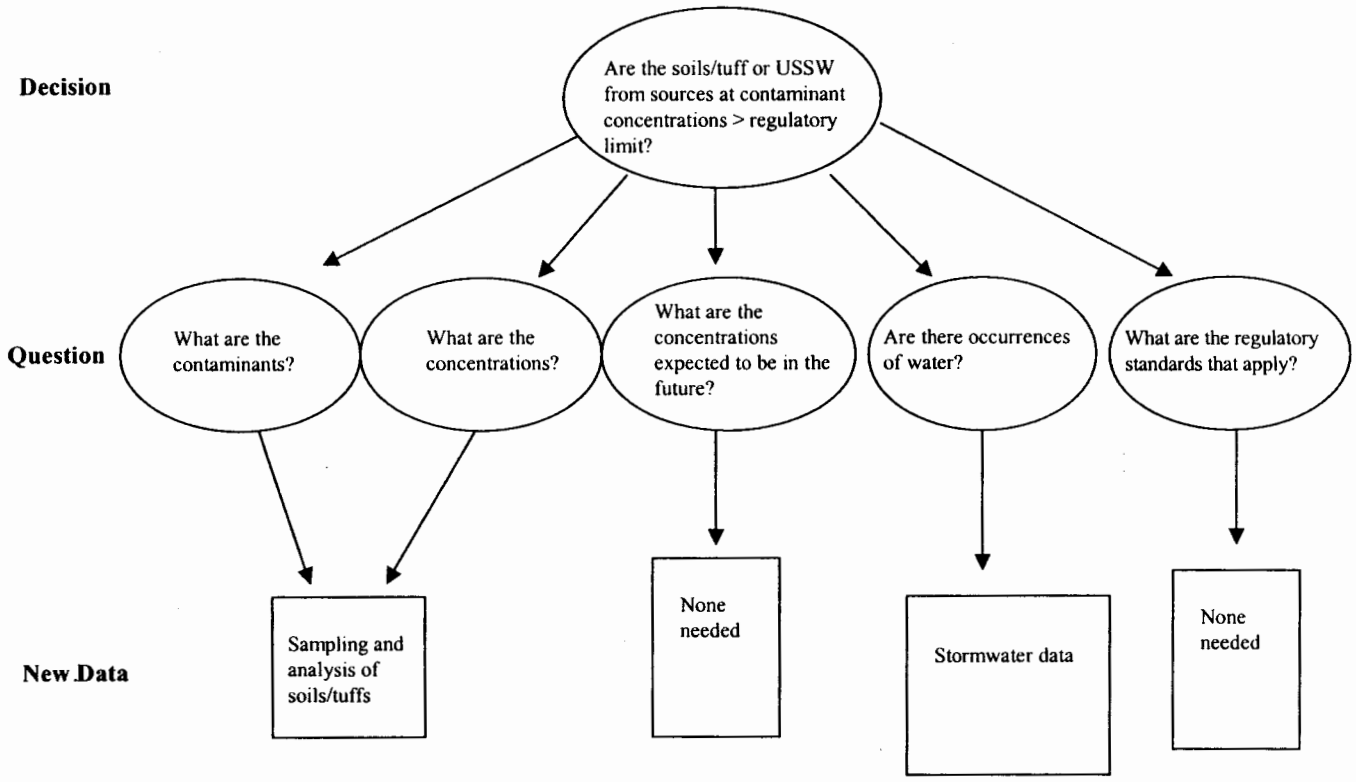


Figure 8: Mesa Decision 2

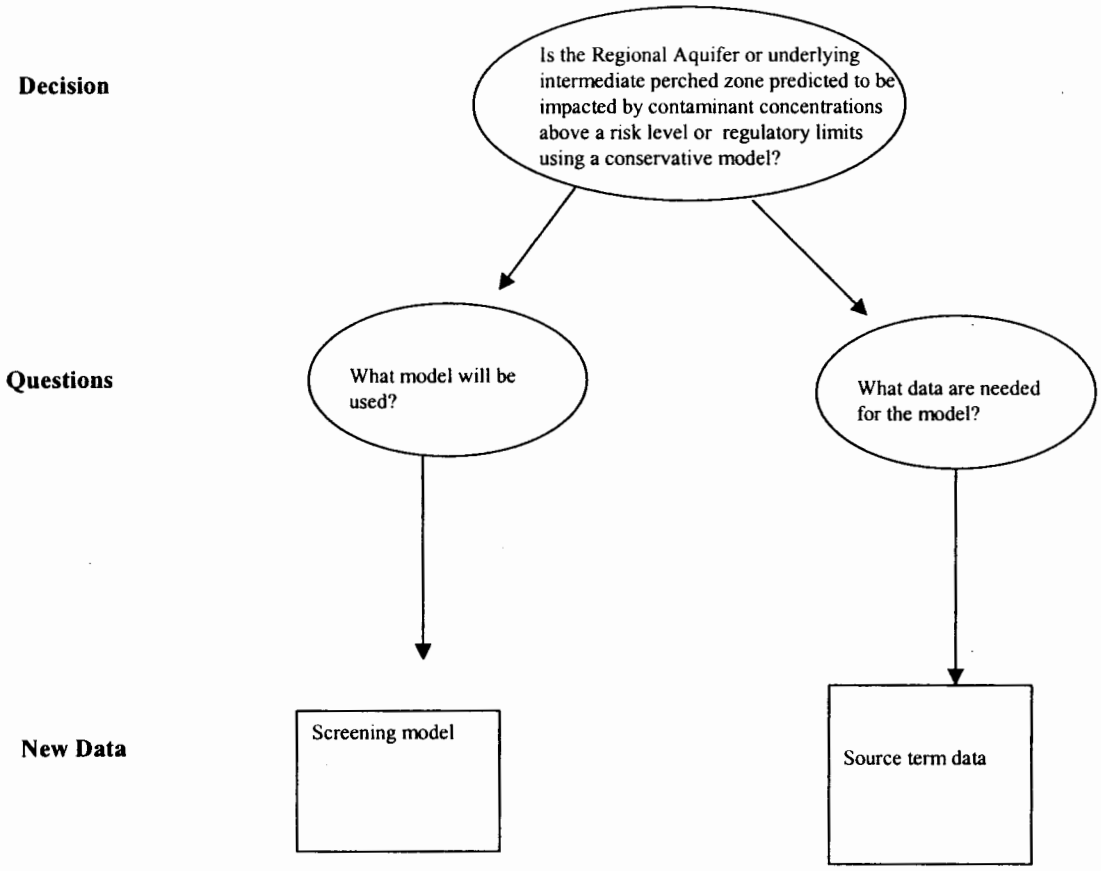


Figure 9: Mesa Decision 3

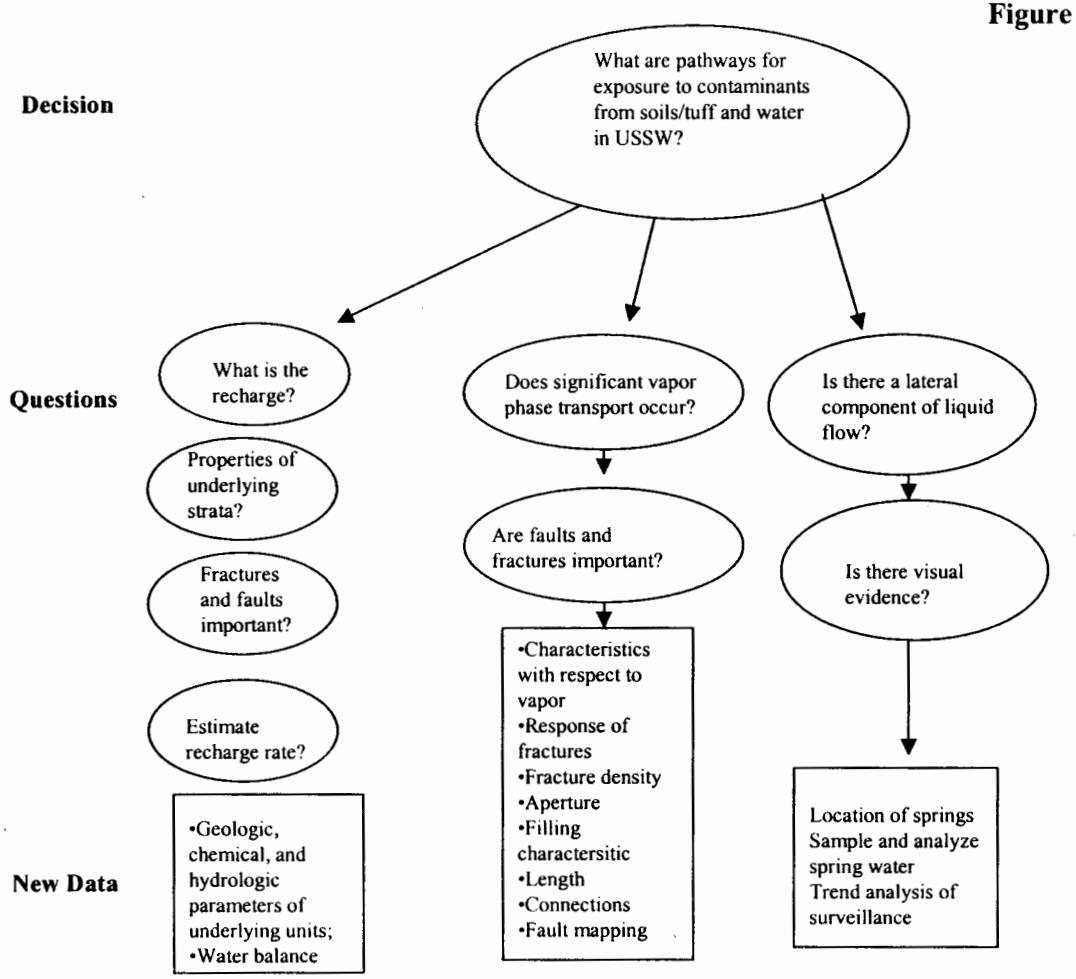
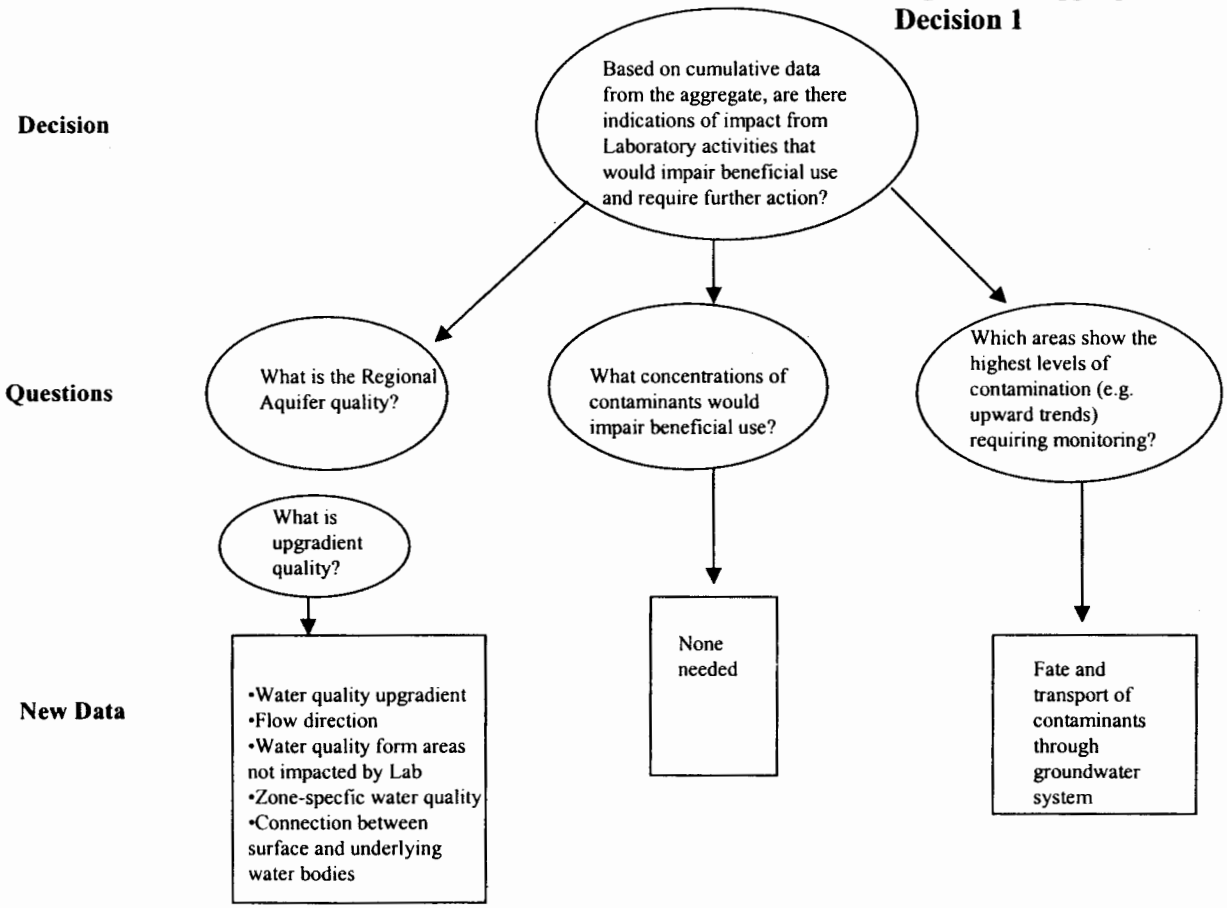


Figure 10: Aggregate Decision 1



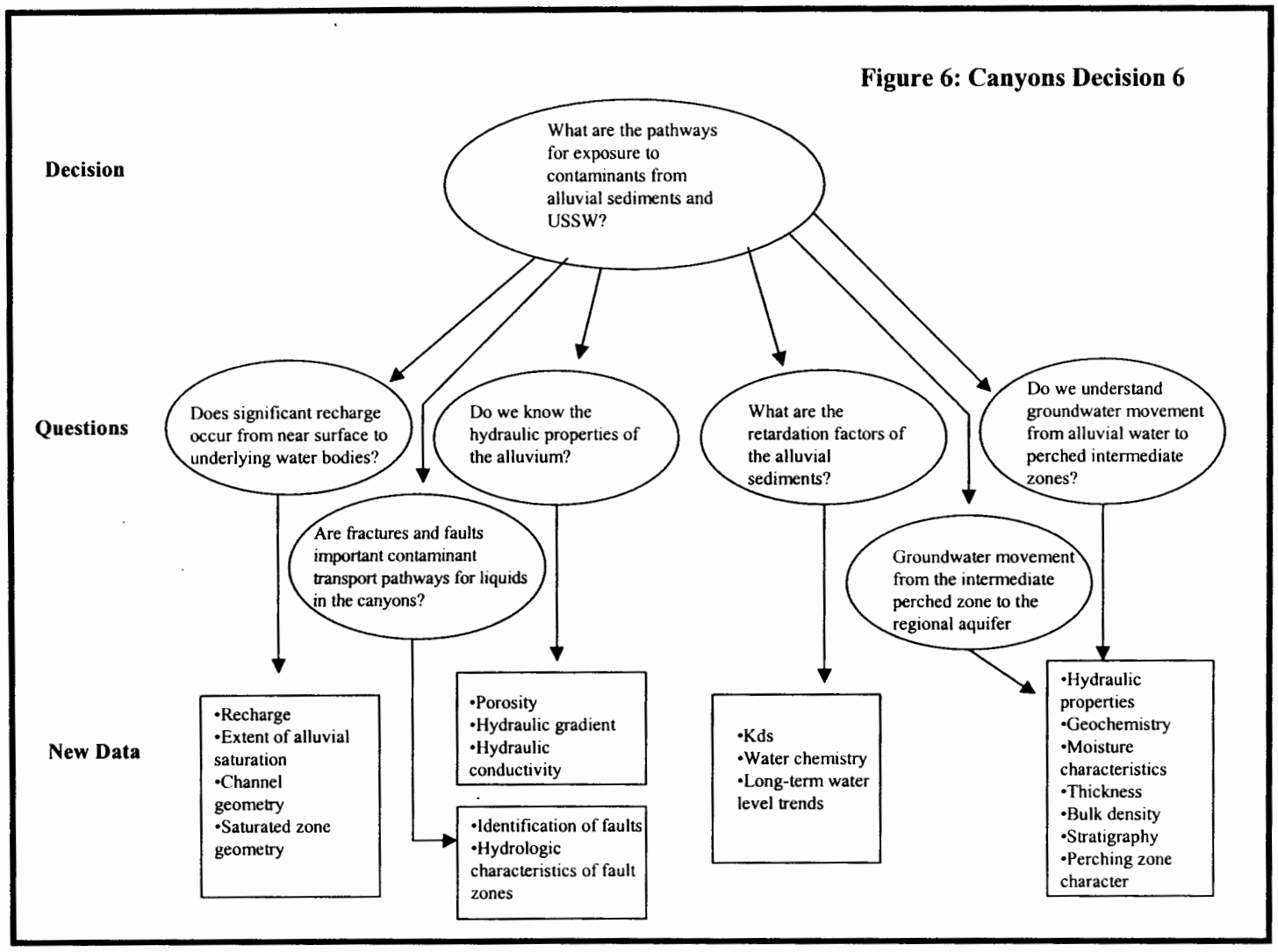


Figure 6: Canyons Decision 6
Decision
What are the pathways for exposure to contaminants from alluvial sediments and USSW?
Questions
Does significant recharge occur from near surface to underlying water bodies?
Do we know the hydraulic properties of the alluvium?
What are the retardation factors of the alluvial sediments?
Do we understand groundwater movement from alluvial water to perched intermediate zones?
Are fractures and faults important contaminant transport pathways for liquids in the canyons?
Groundwater movement from the intermediate perched zone to the regional aquifer
New Data
•Recharge
•Extent of alluvial saturation
•Channel geometry
•Saturated zone geometry
•Porosity
•Hydraulic gradient
•Hydraulic conductivity
•Identification of faults
•Hydrologic characteristics of fault zones
•Kds
•Water chemistry
•Long-term water level trends
•Hydraulic properties
•Geochemistry
•Moisture characteristics
•Thickness
•Bulk density
•Stratigraphy
•Perching zone character