S. HRG. 107–318

CHILDHOOD LEUKEMIA CLUSTERS IN FALLON, NV

FIELD HEARING

BEFORE THE

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS UNITED STATES SENATE

ONE HUNDRED SEVENTH CONGRESS

FIRST SESSION

ON

RESPONSES BY THE FEDERAL GOVERNMENT TO "DISEASE CLUSTERS" RESULTING FROM POSSIBLE ENVIRONMENTAL HAZARDS

APRIL 12, 2001—FALLON, NV

Printed for the use of the Committee on Environment and Public Works

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ONE HUNDRED SEVENTH CONGRESS
FIRST SESSION

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CHILDHOOD LEUKEMIA CLUSTERS IN FALLON, NV

THURSDAY, APRIL 12, 2001

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
Fallon, NV.

The committee met, pursuant to notice, at 9:00 a.m., at the Fallon Convention Center, 100 Campus Way, Fallon, NV, Hon. Harry Reid (acting chairman of the committee) presiding.

Present: Senators Reid, Ensign, and Clinton.

Also present: Representative Gibbons.

OPENING STATEMENT OF HON. HARRY REID, U.S. SENATOR FROM THE STATE OF NEVADA

Senator REID. The United States Committee on Environment and Public Works is called to order.

First of all, I'd like to welcome everyone here. This is what we call a field hearing. I'm particularly thankful for the support that we've gotten from the community in Fallon. It's been a lot of work to put this together and the hosts have worked very hard to provide this facility for us and to work with the staffs of the various Members of Congress who are concerned about what's taking place in Fallon. This has been a community effort, as I mentioned. All local officials have been cooperative, and especially the parents of the children who are sick.

I'm fortunate today to have with me my two colleagues from Nevada, Senator Ensign and Representative Gibbons. Senator Clinton will be here shortly. Her plane is about to land. When she arrives, I'll say a couple things about her. I want everyone to know, by virtue of my being the Ranking Member of this committee and also under the auspices of Chairman Bob Smith of New Hampshire, I have extended an invitation to Senator Ensign and Representative Gibbons to act as *de facto* members of this committee today. I'm also pleased, of course, to have with us the Governor of the State of Nevada, Kenny Guinn, Assemblywoman de Braga, and Senator McGinness, who have expressed to me their deep concern about the incidence of leukemia in Fallon. I want to extend a special welcome to our witnesses, some of whom have traveled great distances to be with us here today. We're extremely fortunate to have national experts on a range of issues important to the community, including children's health, childhood leukemia, cancer clusters, and environmentally-related health problems, as well as State, local, and U.S. Navy officials, with a wealth of expertise and a demonstrated com-

mitment to addressing the difficult circumstances surrounding the citizens of Fallon.

The second goal of this hearing is to examine the Federal Government's approach to identifying and responding to so-called disease clusters, including health problems that may be linked to environmental conditions. There's a widespread concern among the citizens of this country about our being exposed in our day-to-day lives and about what we're exposed to and what effect exposures may have on our health and especially the health of our children. While a number of Federal agencies are doing an excellent job of supporting State and local officials in addressing community health concerns, the support system often seems uncoordinated, ad hoc, too little, and many times too late. So I believe the time has come for the Federal Government to craft a coordinated approach for responding to the needs of communities for support and guidance in identifying and addressing disease clusters and outbreaks.

Now, here's how we're going to proceed today. After the opening statements of my colleagues, we're going to have three panels of witnesses. The witnesses on the first panel will make remarks of up to 5 minutes, then we'll have questions of the panel members from the Members of Congress, and then we'll proceed to the second and third panels the same way. Preceding these panels, we're going to hear from the Governor of the State of Nevada, Kenny Guinn. After the third panel has finished with questions, there will have been circulated in the audience little cards, and any questions that people have to ask Representative Gibbons, Senator Clinton, Senator Ensign, or myself, we will be happy to answer those, time permitting. Those questions that are in writing that have your address on them, if we don't have the opportunity to respond today, we will respond to those in writing. The cards are in the lobby, and we'll make sure that they're circulated also, for those of you who missed them when you came in.

We must complete this hearing by one o'clock today. There's another event scheduled to take place in this room this afternoon. Mayor Tedford has worked minor miracles to provide us the space, and I have assured him, my staff has assured him, that we'll wrap this up in time for him to set up for the next event. If anyone wants to submit written testimony, please do so. The hearing record will remain open for 1 week. Testimony provided by April 19 will be included in the record.

I think also one of the important things that I want to talk about is—and we make mistakes here. My staff gave me my pages in reverse order. So I'm now on page 3—I'm on page 2, I'm supposed to be on page 3, but it's a minor problem. We're going to look at a very complex problem, as I've indicated. I have 5 children and soon will have 11 grandchildren, and I can think of nothing more heart-breaking than a childhood suffering from a serious health condition and nothing more frustrating than not knowing the cause of that condition. So, today, we're going to examine all of this, and we've got people who will help provide some answers. We're facing a very complex problem, people should understand, and I'm not going to pretend that there's going to be easy answers to the questions, but this committee is committed to give the full weight of the Federal Government toward answering the many questions that

have been posed. In this room today we have a unique opportunity to share in the experience of working on the goals of Fallon and nationally. One of these goals is to find ways in which the Federal Government can help join Federal, State, and local, and even private sources, to support ongoing investigations in the high incidence of childhood leukemia in this community and address any other environmentally-related concerns. I want to applaud the State of Nevada, Governor Guinn, for the work that has been done at this point. I think that other States could take a lesson from the work that has been done here, and from those of us who work in Washington, we've watched and certainly applaud your efforts.

We're going to now hear from Senator Ensign, Representative Gibbons, and then Senator Clinton will probably be here by then.

[The prepared statement of Senator Reid follows:]

STATEMENT OF HON. HARRY REID, U.S. SENATOR FROM THE STATE OF NEVADA

I'd like to welcome everyone to this field hearing of the U.S. Senate Environment and Public Works Committee.

I'd particularly like to thank the Fallon community for the hard work and support that has gone into hosting this event. And, I'd like to recognize in advance the family and community members, and local officials, for participating in the hearing: as the people closest to the issues to be addressed, your testimony is vital.

I'm fortunate to be joined by one of my newest colleagues on the committee, Senator Hillary Rodham Clinton. In addition to her longstanding commitment to children's health and to a clean environment, Senator Clinton is facing some of the same challenges facing us here, in connection with a cancer cluster in a community in her State of New York.

I have also by virtue of my being the ranking member of this committee, and under the auspices of Chairman Bob Smith of New Hampshire, invited my colleague John Ensign and Congressman Jim Gibbons to act as *de facto* committee members.

I'm also pleased to be joined by Governor Guinn, Assemblywoman de Braga, and Senator McGinness, who I know share my deep concern about the high incidence of childhood leukemia in Fallon.

And, I want to extend a special welcome to our witnesses, some of whom have traveled great distances to be here. We are extremely fortunate to have national experts on a range of issues important to the community—including children's health, childhood leukemia, cancer clusters, and environment-related health problems—as well as State, local and United States Navy officials with a wealth of expertise and demonstrated commitment to addressing the difficult circumstances facing the citizens of Fallon and the surrounding area.

Today we will examine what I consider to be one of the most pressing issues facing this community and our Nation: how we can support and enhance the response to environment-related health threats, and health outbreaks such as the high incidence of childhood leukemia here in the Fallon area. Quality investigations into the factors that contribute to these health problems will enable us to better protect public health through preventative measures, and through more effective response when disease clusters and outbreaks do occur.

As the father of five children, and grandfather of soon to be eleven, I can think of nothing more heartbreaking than a child suffering with a serious health condition, and nothing more frustrating than not knowing the cause. Yes, we are facing a highly complex situation, and I'm not going to pretend that I think there are easy answers. But, this committee commits to give the full weight of the Federal Government toward answering the many questions herein posed.

Here in this room today we have a unique opportunity for sharing experience and expertise toward our common goals, in Fallon and nationally.

One of those goals is to identify ways in which the Federal Government can help to join Federal, State and local resources to support ongoing investigations into the high incidence of childhood leukemia in this community and address any other environment-related health concerns. I applaud the State of Nevada for its tireless work on this issue.

A second goal of this hearing is to examine the Federal Government's approach to identifying and responding to so-called disease "clusters"—including health problems that may be linked to environmental conditions. There is widespread concern among the citizens of this country about what we are exposed to in our day to day

lives, and what effect exposures may have on our health and the health of our children. While a number of Federal agencies are doing an excellent job supporting State and local officials in addressing community health concerns, the support system often seems uncoordinated, ad hoc, and too little too late.

The time has come for the Federal Government to craft a coordinated approach for responding to the needs of communities for support and guidance in identifying and addressing disease clusters and outbreaks.

Here's how we'll proceed. After brief opening statements by my colleagues, we have three panels of witnesses. Witnesses on the first panel will make remarks of up to 5 minutes each. Then we'll ask some questions of the panel. The same for the second and third panels.

After the third panel has finished with questions, and if time allows, we will provide answers to questions raised by people attending this hearing. You may submit written questions by filling out one of the cards located on the table in the lobby—these cards also will be distributed by staff. If we do not have time to get to all of the questions, we will send a written response if you include your address on the card.

We will need to complete the hearing by 1 p.m., as another event is scheduled to take place in the room this afternoon. I recognize that Mayor Tedford has worked minor miracles to provide us this space, and I have assured him we'll be sure to wrap up in time for the room to be set up for the next event.

If anyone wants to submit written testimony, I encourage them to do so. The hearing record will be open for 1 week—testimony provided by April 19 will be included in the record. With that, I welcome my colleagues.

Senator REID. Senator Ensign?

OPENING STATEMENT OF HON. JOHN ENSIGN, U.S. SENATOR FROM THE STATE OF NEVADA

Senator ENSIGN. Thank you, Mr. Chairman. I want to personally thank you for not only convening this hearing, but also for inviting Representative Gibbons and myself to appear at the hearing and to participate. This is an incredibly emotional issue. I think all of our prayers and sympathies go out to the families. I myself have three children. Two of our children have had fairly serious medical problems—and the nights that you spend in a hospital with your children are very painful, probably more painful for parents sometimes than they are for the children. So I think all of our sympathies and prayers go out to the families.

It's because of those emotions that we're here to recognize work that is being done by everybody concerned. It's important because we need to, find causes for these clusters. Most of the time we aren't able to find the causes, but that should not stop us from pursuing them. What if this happens to be the cluster that gives us the breakthrough to stop, clusters in the future. That's why maybe some good can come out of this tragedy that has befallen this community. This situation illustrates the importance of everyone working together—the Federal Government, the State government, the local government, private entities, and the military—putting their best effort forward to be able to try to come up with a cause so that we don't have these types of things happening in the future. We all know that prevention is the best type of medicine, and if we can discover a cause, perhaps we eventually can come up with prevention measures in the future.

So I want to, once again, thank the chairman. Senator Reid and I have been working together since I took office in the Senate. I just was informed today that I've been a Senator now for 100 days as of today, along with my colleague, Senator Clinton. As all of you know, Senator Reid and I had kind of a rough and tumble election 2 years ago. However, this is the type of positive relationship that

the people of Nevada can look forward to, with the two of us working together, with the rest of the congressional delegation, other Senators and our Governor and members of the State senate and assembly, working together to try to find solutions for Nevada problems. As you'll hear later from Senator Clinton, this is not just a Nevada problem. This is a national problem, and even a worldwide problem.

So thank you, Senator Reid, for allowing me to be here.

STATEMENT OF HON. JIM GIBBONS, U.S. REPRESENTATIVE FROM THE STATE OF NEVADA

Mr. GIBBONS. I want to associate myself with the remarks of Senator Reid and Senator Ensign with regard to the importance of this issue, the sympathies that we have and share with families who are afflicted by this disease. All of us sitting here today have children, all of us know and understand the importance of their lives and their future and the effect that something like this could have, not only on them, but on their community as well. The purpose, I believe, of this hearing today is for us to gain the information, for us to gain the knowledge, if it is possible, to help both the families, the children, and this community survive and overcome this terrible incidence of leukemia.

There is so much to be learned, there's so much that we don't know. It is very difficult, in my mind, to find the answer or to point a finger at this point in time as to the culprit of this disease. So we are here today—and certainly it can be shown, by the number of people in this room and their acute interest in this subject, the high profile that this issue has. Hopefully, as Senator Ensign has said, what we will receive is information that will help us overcome this issue, and will help not only the families and the children afflicted, but also the community, so that this community can move on and remain one of the great Nevada communities that has already been and will be in the future.

So thank you, Senator Reid, once again for having me here today. It's indeed my pleasure to sit on a dais with such distinguished members of the U.S. Senate.

Senator REID. I've just been advised that Senator Clinton's airplane has landed. We'll reserve her statement until she arrives.

Governor Guinn.

STATEMENT OF HON. KENNY GUINN, GOVERNOR, STATE OF NEVADA

Governor GUINN. Thank you very much, Chairman Reid, Senator Ensign and Congressman Gibbons. It's a pleasure to have you here and soon, hopefully to arrive, Senator Clinton.

We here in Nevada have been working with this problem over the past year or so now, and we want to certainly thank all of you for having the interest to come here to hear the expert testimony that you will receive from Dr. Guinan and our staff. They have worked very hard. They have been focused on the issues at hand in terms of leukemia and cancer, the problem that we have here with the ALL in this community. It is certainly a serious concern for all the parents and the children who are involved, but it's also a serious concern for those who live in Fallon and for those of us

who live in the State of Nevada. So it's greatly appreciated, the fact that you would take the time out of your busy schedule to come here to hear this testimony that you will hear today.

Dr. Guinan and her staff have worked diligently and they have been very closely coordinated with the CDC, which has given us great guidance and help, and also the expert review committee that is set up. So, today, as you see the process that they travel through and the great detail that they have been working on, I think you will be impressed. By the same token, this is not just a Fallon issue or a Nevada issue, I truly believe that cancer clusters have been established throughout this country over the years. Some have been unknown for the last 20-plus years. It is time for those of you who have the wherewithal and the ability to coordinate this on a national level to do so, and I truly appreciate—and hopefully that will be your guidance as you come out of this program here today, after hearing the testimony.

Certainly, it is the unknown that causes the frustration. When there is an issue like this—and we know about cancer, but if you do not know the agent that is creating the cancer cluster, then it becomes an area that is of fear and not understanding that unknown. So, today, when you hear these issues, if there's anything you can do to help us to promote it more on a coordinated basis, which I'm sure you will do, and take it throughout this great land of ours in America, then we will all be better for having this hearing here today.

I will leave the rest of the information that you'll get from the State of Nevada, certainly from these experts, who have worked day and night. Over five full-time staff people have been allocated to this, but the real support that we've received so far is from the staff of the CDC and also from these expert oversight members, who come from some of the very best cancer research areas of the universities. So hopefully today you will hear a great deal of detail on what the study has been doing, and if there's anything you can do to help us after that, I'm sure the citizens of Fallon in this great State of ours will most appreciate it.

Senator REID. Governor Guinn, we appreciate your being here today. You and I spoke before the hearing started, and we understand you have a legislative session that's in full blow at this time and you've got to get back and protect the interests of the State, and we want you to do so. We appreciate your taking time out for this. There's no busier time than when the legislature's in session. So you're excused, and we appreciate your being here.

Governor GUINN. Thank you very much. We will cooperate and provide you with all the data and do everything we can to help you formulate your plan and your ideas for all Americans. Thank you very much.

Senator REID. We would now like to hear from Mike McGinness, who is the Senator who represents this area. Senator McGinness, we also appreciate your being here, with the legislature being in session. We would ask you to address the committee now and tell us what you feel is appropriate.

STATEMENT OF HON. MIKE McGINNESS, STATE SENATOR, NEVADA

Senator McGINNESS. Senator Reid, thank you very much. I appreciate the opportunity to be here. Senator Ensign, Congressman Gibbons. As you mentioned, Senator Reid, I too will be heading back to Carson City. The judiciary committee has a large work session today. Congressman Gibbons and I were freshmen in the judiciary committee in the assembly in 1989. We do have some deadlines, but I appreciate the opportunity to be here today.

For the record, I'm Nevada State Senator Mike McGinness, representing the central Nevada Senatorial district. I appreciate the opportunity to provide testimony. Fallon, NV, is my birthplace. In fact, about a hundred yards down the road here, there was a clinic where I was born. I'm here because of the concern for the children and these families that are facing such trials. Again, I wish to thank the committee for making these children such a priority. Your attention to their illness can only contribute to the awareness and assist in the current investigation. I would like to thank Governor Guinn. When he convened all the parties earlier this year, there was a genuine spirit of cooperation to work toward seeking information and peace of mind for the children and their families, and I encourage a continued collaboration in the investigation.

I have great confidence in the leadership of this community. There's a rich history of strong progressive leaders, individuals that have acted responsibly since the discovery of this cluster. Many of us have difficulty dealing with the negative publicity, since the very reputation of this community has been questioned. The community has responded to the needs of the families at every available opportunity, and I know they'll continue to do so. We want the community, the State, and the Nation to know that Fallon, NV, will find the cause and cure for this malady today, if possible.

Particularly pleasing is news that the Centers for Disease Control will move the investigation to a new level. The CDC will be in Fallon on Tuesday to begin phase two of the investigation. As Federal officials, anything you can do to expedite their investigation will be appreciated. The community can take comfort in the fact that government at all levels is acting responsibly. I would hope that the committee finds that credit is due to the city of Fallon, Churchill County, the State of Nevada, the U.S. Navy, and the Federal agencies for their response. Anything that can be done will be done.

In closing, let me thank you again for coming to Fallon and making the care and comfort of these children and their families a priority, and I appreciate the opportunity.

Senator REID. Senator, good luck on the remaining 60 days or so.

Senator Clinton, you came at a very appropriate time. We've just completed hearing from Governor Guinn and the State Senator who represents this area, Senator McGinness. We indicated that your plane was a little bit late. Let me say to everyone here assembled, as Senator Ensign indicated, Senator Clinton—this is her hundredth day of being in the U.S. Senate, and this is the first time that she has traveled outside the State of New York to do business. We all have been involved in things in Washington. I personally am very glad that she's on our committee, the Environment

and Public Works Committee. As you've seen reported in the press in recent days, she has done a tremendous job on this committee and in the Senate, and we're fortunate that she's here in Fallon with us today.

Senator Clinton, would you give us an opening statement?

OPENING STATEMENT OF HON. HILLARY RODHAM CLINTON, U.S. SENATOR FROM THE STATE OF NEW YORK

Senator CLINTON. Thank you, and I'm delighted to be here. I apologize for being a little bit late. It took longer than I thought, but I got to see some beautiful country as I flew over. I'm very pleased to have this opportunity to join the Congressman and my colleagues, Senator Ensign and Senator Reid, for this important hearing. I know that we wish we weren't here in a way. We wish we were here for some other reason. I'd love to come back to Fallon and get to know more about what goes on in this community and have a chance to learn more about what our naval base does or what the agricultural interests are, but we're here because we have a very sensitive and difficult issue to address, and it's one that I care deeply about.

As Senator Reid might have said, we have cancer clusters throughout our country. We certainly have them in New York, and I think even some of the witnesses we're going to hear from today will speak of some of those. There's a high school in a place called Elmira, NY. For reasons we haven't yet been able to determine, there are a number of cancers in our children who attended that school, and, suprisingly, there's no way yet that we can understand the reasons for it. We know it's built on an old industrial site. We know that's a community that has had a lot of heavy industry, going back to the Civil War. So we're looking for answers. We have breast cancer clusters throughout New York. Some of the highest rates of breast cancer can be found anywhere in our country. This is not something that is confined to Nevada or New York, it's something that we face around America, and I think that the Congressman and the Senators and I are here today to hear from you and to hear from experts who have been looking into the issues surrounding the leukemia here in Fallon with the hope that we will be able to put together some information and recommendations that could possibly lead to answers.

I want to thank my friend, Senator Reid, for holding this hearing. It's such a pleasure working with him, serving with him. I'm delighted that it's also the hundredth day for Senator Ensign, whom I've had the pleasure of getting to know over the last months. I've known Senator Reid for a number of years, and I see Mrs. Reid here, and there aren't two people who are more dedicated and devoted to the people of Nevada than they are, and the service that he's given over the years really stands alone and what he does every day to make the Senate run, which is no easy task, I have learned, is remarkable in and of itself. So I want to thank him, not only for his leadership, but for his friendship as well.

We're going to work in a bipartisan way to deal with the environmental challenges that face us, the health care challenges that we confront. I'm looking forward to hearing from the witnesses, because they're really the reason for this hearing, and then taking

what we learn and going back to Washington and, again, working in a bipartisan manner, working with members of the House as well as the Senate to try to find some answers, and I appreciate all of you giving me the honor of being able to attend today.

Thank you very much.

Senator REID. The first panel that we're going to hear from today consists of Assemblyperson Marcia de Braga, who has devoted weeks and weeks of her life to the problem that faces her district, her assembly district; Ms. Brenda Gross, a mother of a child with leukemia from Fallon, NV; and Tammy Beardsley, a mother of another child with leukemia in Fallon, NV. On this same panel, if you would step forward, please, we're going to hear from Dr. Stephen Prescott. Dr. Prescott is from the Huntsman Cancer Institute at the University of Utah, in Salt Lake City. Dr. Prescott is one of the leading experts in the world on cancer generally, and we're very fortunate that he's traveled to Fallon from Salt Lake to share his expertise with us.

I would remind the witnesses that we all have a lot to say, we have a number of questions that—we've reviewed what you're going to talk about and the questions we want to ask. So if you would do your best to stay within the 5-minute guideline, it would be appreciated. You'll see these little lights up here. Green means you're in good shape, yellow means you have a minute to go, and red means you're out of time. So do the best you can. We're not going to call for the sergeant-in-arms to throw you out if you go a little bit over, but we do have to meet the responsibilities that we have with the mayor in getting us out of here by 1 o'clock. We're going to take no breaks during the hearing. The court reporter's fingers are—we have a reporter that has the best fingers in northern Nevada. She said she can take testimony for 4 hours, and we're going to test her and see if she can.

Assemblywoman de Braga, please proceed.

STATEMENT OF MARCIA DE BRAGA, ASSEMBLYWOMAN

Ms. DE BRAGA. Thank you. It's a great pleasure to welcome you to Fallon, and we want to thank you for convening these hearings. In the fall of 1999, I read with sadness a story in our local newspaper about a fund-raiser for a 5-year-old who had ALL, acute lymphocytic leukemia, and then there were a few more cases and more sad stories. I called the State health division and asked if they thought that four cases of ALL in 3 months was an unusually high number in a small community like ours. I was told it might be just an isolated cluster, but they would look into it. In less than a year, eight more cases were discovered. The statistical probability of this number of cases occurring in an area with our population is 1 in 10 quintillion. In other words, there is almost zero possibility that this cluster happened by chance.

In mid-February, the Assembly Natural Resources Committee, which I chair, held 3 days of legislative hearings. The purpose of the hearings was to bring together the experts, the data, the research, the knowledge, funds, and other resources in an effort to expedite the search for an environmental cause or contributing factors. The hearings also served to attract considerable media attention and with it a great many offers and promises from individuals

and agencies and from local and State and national officials to work together for a common and urgent purpose.

Others testifying will give you statistics and progress reports. What I want to focus on is what I learned through the legislative hearings and through listening to the people whose lives have been affected by this tragedy. As a result of the hearings, we prepared a list of possible causes created from our research and the testimony we received. The entire list is in your packet, along with the names and agencies of individuals that our recommendations have been forwarded to. It basically asks those in authority to leave absolutely no stone unturned. Our recommendations also include providing information to the public and expanding the scope of the investigations to cover a longer period of time, other disease groupings, the analyzing of water, soil, and air, and the testing of blood, bone, tissue, and hair of the children. I'm happy to report that yesterday the Assembly Ways and Means Committee approved $500,000 to be used specifically for those purposes.

In addition, the committee recommends cleaning up the things that our community is concerned about, and doing it now and not waiting for science to catch up or to provide positive proof. We unanimously agree that the cancer registry and other data must be processed in a rapid manner, so that information is current and readily available to help the environmental officials and the general public.

This leukemia cluster may only be a part of the whole picture. An eminent pediatric oncologist has advised us to investigate all marrow diseases and to look for any increases in other forms of cancer among children and adults. We know that two additional ALL cases were diagnosed in 1992, and in 1991, a 5-year-old died from myelodysplastic syndrome, a less common form of leukemia. We know that earlier this year a youngster was diagnosed with aplastic anemia, another marrow disease. We know that there may be additional cases that are connected to Fallon but were not diagnosed here, and we know that there are clusters of other diseases that are also suspicious.

I think it's vitally important that everyone involved be proactive and not rely on old data, that we look beyond the environmental improvements that are already being done to what needs to be done next, and that we approach our problems with the hope and optimism that through determination and perseverance we can, if not find a definitive answer, at least eliminate possible causes and add to our information base.

Our legislative committee has sponsored a bill that would require public and private entities certified to do environmental testing to report to the Nevada State Health Division or NDEP any findings of specific values that exceed the established maximum contaminant levels. Those findings would have to be made public if a significant health risk was posed. I think it's imperative that we put these protections into law and aggressively pursue our search for causes. That includes working to eliminate known contaminants. In so doing, obviously we improve the general health of all contributors.

Why do I feel so strongly that we have a responsibility to move forward in every way possible? Because this is about children, chil-

dren whose lives have been turned upside down by something terrible that's beyond their control. This is about a beautiful, smiling little girl whose hair is gone. This is about a promising young athlete whose energy now lasts for only minutes. This is about a teenager whose HMO won't pay for a bone marrow transplant. This is about furthering what is known about cancer so that communities might be spared what happened here. I applaud your efforts to create a nationwide team to deal with these situations, if and when they arise.

Senator Clinton, I read that you said, "There is no such thing as other people's children." You, Senator Reid, Senator Ensign and Congressman Gibbons have clearly demonstrated that belief by coming to Fallon to hold these hearings. We can't thank you enough for your concern and your willingness to help our community and communities like this everywhere.

Thank you.

Senator REID. We're going to now hear from Brenda Gross. She really has raised the consciousness of the entire community to this terrible disease. She's the mother of four children. Her testimony was one of the highlights of Assemblywoman de Braga's hearings.

Would you, please, proceed.

STATEMENT OF BRENDA GROSS, FALLON, NV

Ms. GROSS. Thank you and good morning.

I would like to thank you for allowing me this time to express my thoughts and share with you some of the hardships that my son and my family went through. I'm here today speaking to you to stress the importance of an aggressive approach on this investigation. My son, Dustin Gross, is 5 years old. He was diagnosed April 17, 1999. He is doing very well today, and I'm very thankful for that. We went through some very hard and trying times. As a parent, when your child is very ill like that and there is a possibility that you could lose them, it is frustrating, because you do not have any—you're the parent, you're supposed to take care of everything and you cannot. You have to rely on the doctors for this, and thank goodness for the doctors.

One thing that I would like to stress is that when going through these things, your child going through many, many blood transfusions, surgeries and such things that are needed, and the chemotherapy treatments, you often wonder, as you're watching this, What did I do? Did I need not feed him correctly? Did I allow him to do things incorrectly? Did I—what, as a parent, did I do wrong? That's why I feel so strongly that we need to find the cause, because we do not want another child to go through this. I feel very strongly that there is a cause. I don't know if it's environmental, I don't know what the cause is, but I do feel that there is a cause here in our community. It is not by coincidence that 12 children have a certain type of leukemia.

I would like to give my thanks and tell my appreciation to the State health department. They have been doing a very good job on their research. Obviously, I wanted to be more aggressive, but I do understand their approach. Some of my ideas are maybe perhaps helping with the State health department, such as needed funding, needed manpower, expert team assistance, CDC assistance, what-

ever it takes, whatever type of testing it takes to protect our children.

A couple of my concerns—and I have mentioned this to the State health department—that I'd like to express to you is, on some of the testing—and I want to stress I'm not pinpointing any of this as being the cause, but when they do the research on the base, the naval base, and look at how they release—we'll just say the jet fuel, because that's been an issue—and how this is monitored and tested and researched, my understanding—and I may be incorrect, but my understanding is that it is the Department of Defense and the naval base and the Government that does this research and tracks and monitors all of this. I would like to see an outside company come in. I'm not saying that they are doing anything incorrect, but they do this, my understanding, on a continuous basis, these tests and checking things out. It might become habitual to them, because it is their job, and maybe we need an outside firm or company to come in there and look things over in a different point of view.

Another thing is, I feel that the research with these clusters, we should try to check the other clusters in our Nation, see if there's a common link there. I just think a national-type—and if we could do a national panel or what not—I mean, I don't know how that works, but I think that that would definitely benefit the research.

Also, third, I do not know if our State of Nevada has a location or a center for the doctors to send their reports to for these cancers. Do we have one—I know that a lot of it goes to CDC, but do we have something that is just for the State of Nevada for tracking? Because sometimes, to my understanding, the CDC gets behind on some of this. Do we have something here for our State to track these clusters or cancers?

Senator REID. You'll hear from Dr. Prescott. He has some information on that.

Ms. GROSS. Great, thank you.

I would also like to thank our community. This community has been wonderful and overwhelming and very supportive, and I love living here and I love Fallon. My focal point throughout this whole testimony is to continue the aggressive research on this, not to let up on it. Even as we continue in our lives and this—hopefully we don't have another childhood that gets leukemia—and it kind of goes by the wayside, I hope we don't let up on it. I want to stress to push this very strong. It sounds to me these clusters have been going on for many years, and that's too many years.

Senator REID. It's very difficult to have a mother of a sick child come and testify in front of TV cameras and all the people here assembled. We're fortunate that not only have we heard from Brenda Gross, but we also are going to hear from Tammy Beardsley, who did not want to be here, but she's here.

Would you, please, proceed.

STATEMENT OF TAMMY BEARDSLEY, FALLON, NV

Ms. BEARDSLEY. Thank you, Senator Reid.

Forgive me if I'm a little nervous. I threw this together very quickly, and I probably won't be as well read as Brenda, but I'm going to try and speak from my heart. I also was born and raised

here, and I also love this community very much and I'm here just to help.

I'm here to represent my 5-year-old son, Zach, who was born healthy, no list of health problems, no history of health problems and, yet, he has cancer. If I'm a bit shaken, he just got back from Oakland last night for some procedures and he's recovering today. So my husband's not here. So my emotions are a little high. Forgive me if I whittle my words.

I'm not sure what made Zach so sick, and while I don't think it has anything to do with the arsenic in the water, I do think we need to make better choices when it comes to our environment. I drive by and I see cows, hundreds of them, in one pen, and when they waste on each other, we give them lots of antibiotics to make them healthy. We want them to produce fresh meat and eggs and cheese and all the rest of it and, yet, their living conditions aren't healthy. I think we need to look into that. I think we need to look into how much stuff are we gonna throw out, how much stuff are we gonna buy, how much money do we all need, how many new homes do we need to build? We really need to talk about this. I'm talking from my heart now to my fellow human beings. If we don't stop buying more than we need, if we don't stop eating more than we need to eat, if we don't stop throwing out food, if we don't stop wasting so much of our planet, we're going to start seeing more and more sick children.

I come from a very healthy family. I'm in the fitness business, I'm in the nutrition business. My children have lived healthy lives, and now we're fighting cancer. I don't know how I got in this mess, and, of course, I want out of it, but I think we need to take a look at the way we're treating our home—not our home, but our planet, because I think we're going to create more disease and I think we're going to create more sick children. I think we need to take a look at the way we treat animals, the way we treat our home, the way we treat each other, and maybe we can stop creating sick children.

Senator REID. Thank you very much.

We now have the opportunity to hear from Dr. Stephen Prescott, who's the executive director of—who is accompanied by Dr. Joseph Simone, the senior clinical director of the Huntsman Cancer Institute in Salt Lake City, part of the University of Utah.

This cancer clinic, Dr. Prescott, I hope you'll tell us a little bit more about it, but we in Nevada are so fortunate through the good offices of the University of Utah, especially the generosity of one man, John Huntsman, who has given about a quarter of a billion dollars of his own money to establish this institute, and the reason it's so important to the State of Nevada is that much of the work that is done there takes into consideration what goes on in northern Nevada.

So, Dr. Prescott, first of all, I would like you to outline your academic background, so the people here in Nevada have some knowledge of who you are and how you came to your job, and then tell us a little bit about the Huntsman Cancer Institute and specifically tell us something about this disease.

STATEMENT OF STEPHEN PRESCOTT, M.D., HUNTSMAN CANCER INSTITUTE, UNIVERSITY OF UTAH

Dr. PRESCOTT. I will do so, Senator Reid. Thank you for having me here and thanks to all the members of the panel. I share Senator Clinton's views. It's very hard to say that I'm pleased to be here, because it's such a sad situation that brings us here.

Speaking of my own background, I'm an immigrant to the Great Basin region. I'm originally from Texas. I've been on the University of Utah faculty since 1982, and for the 10 years before I joined Huntsman Cancer Institute, I was a co-director of the Eccles Institute of Human Genetics, where we focused on trying to find the genetic basis for diseases. We were one of the original centers in the human genome project. We developed much of the technology behind it and its application to human disease. I then became the director of research at Huntsman Cancer Institute and then, about 2 years ago, the executive director.

Senator REID. You are a medical doctor?

Dr. PRESCOTT. I am. I have a medical degree from Baylor College of Medicine, which is in Texas.

Senator Reid, this year, about 2,400 children in the United States will be diagnosed with acute lymphoblastic leukemia, which is what's happened to these children here in Fallon. This is the most common form of childhood cancer. The good news, if there is any to be had, is that the chances for cure for these children is really remarkably different today than it was 25 or 30 years ago. At that time, only about 10 to 20 percent of the children survived this disease. Today, somewhere between 75 and 80 percent will survive. In large part, that was due to the efforts of Dr. Joe Simone, our senior clinical director, when he directed St. Jude's Children's Medical Center in Memphis, TN, where those first dramatic improvements occurred.

These improvements continue, and we believe that one day this will be an entirely curable disorder, but despite this success, there are many challenges ahead of us, and that first one is, quite obviously, as I've just said, the cure rate isn't 100 percent, and until it is, we must work toward that goal. The second goal is that we have to be able to cure these children with fewer side effects. To achieve this, we must uncover the causes of childhood leukemia, and in this regard, we believe the future to be bright. Although we don't know it today, there is great cause for optimism. We just now are beginning to understand the events that cause a single cell to become cancerous, and these advances can be attributed to many types of research, but particularly in the area of genetics.

I want to pause for a minute, because genetics can mean two things. The one easily understandable is, genetic means when you inherit a risk from your parent, and I'm not talking about that today. What I mean, in this case, is the second type of genetics, if you will, in which we acquire damage to our genes during our lifetime. All the rest of the genes in the body are normal, except those that are in the cancerous cells. We now know that ALL happens through this mechanism. The gene that regulates the growth of a cell becomes damaged and it begins to grow abnormally, out of control. It no longer responds to signals from the body that say "stop growing now."

But, as we've heard this morning, the most difficult questions that comes up for a physician or for our government representatives to answer are when a parent asks—and this happens all the time—"Why did my child get leukemia, and was there anything I could've done to prevent it?" It's easiest to answer the second question, and the answer to that is, clearly, no, there was nothing you could've done to prevent it. The answer to why is, unfortunately, we don't know yet.

When clusters, or these dramatic increases in the number of cases in small geographical areas, occur, we always revisit this issue of whether a cancer-causing agent from the environment or an infection resulted in the increased number of cases. It's unfortunate that thus far this approach has not identified any causes for acute lymphoblastic leukemia, but we would argue it is possible that we're missing some subtle relationships, if an environmental or infectious cause is present in the community but only affects a certain fraction of the population. That is, they may have a particular genetic makeup that renders them more susceptible to this infection or to a particular environmental agent. The studies today have not examined that issue, because they simply didn't have the capacity to do so.

The recent completion of the sequencing of the human genome and the technology that it has created has given us an unprecedented opportunity to revisit some of these questions, both about the cause of cancer, such as ALL, and new ways of treatment and prevention. Our specific focus at Huntsman Cancer Institute is exactly this—to understand the genetic blueprint of cancer, and one of our approaches is to use what are called DNA chips. Investigators in our childhood cancer program, led by Dr. Bill Carroll, have used this now to define specific pathways in different types of leukemia, but particularly in ALL. With the understanding of these new pathways, we believe we'll invent new ways to treat children more effectively and with fewer side effects.

We also know that certain of these pathways are unique to groups of patients who will respond well to current treatments and those who will be resistant to treatments or will have relapses. We believe it'll be possible to use these genetic fingerprints to assign children to the two different groups—standard therapy will work or they need a different type of therapy. In fact, this approach will be implemented nationwide within the next few weeks through the Children's Oncology Group—again, on protocols led by Dr. Bill Carroll from our organization. We believe that this someday will lead to the ability to tailor therapy, like a custom-made suit. What will be the best treatment, for this particular type of leukemia in this particular patient, to optimize the chance of cure and to minimize the number of side effects?

As I said before, we believe the same approach could be applied to clusters of ALL or other cancers to try to understand why they occur. For example, we would ask, Is there a specific genetic pathway, one specific pathway that's damaged in all these children in Fallon who have ALL? If this turns out to be the case, it would suggest that there is a common cause in these children. It wouldn't tell us yet whether it's environmental or infectious, but it would say they all followed the same pathway to their cancer. To do this,

responding ad hoc now to Senator Reid's question, one of the things that will be essential is a mechanism to rapidly report the cases to a centralized body and to collect samples. As you know, your expert panel recommended a scheme exactly like this, and I believe it to be crucial that there is a prospective way in which to identify cases, report them rapidly to a central body, and to collect samples under a defined protocol so that we can carry out this type of testing to try to find these pathways.

So in conclusion, although these various projects to define these genetic pathways are just underway or, in some cases, not yet implemented at all, we've made remarkable progress and we believe that by combining sophisticated analysis of DNA changes in patients and in tumors—or in this case, the leukemia cells—that we will have better diagnosis, more rational forms of therapy, and ultimately invent new forms of therapy and prevention.

Thank you.

Senator REID. Now the panel will ask questions of the witnesses, and we'll have 5 minutes to ask questions before we go to the next person, and if we need more questions, we'll do more than one round.

Assemblywoman de Braga, I've heard from a number of people here in Nevada who believe that the number of cancers and other diseases in this area may have been elevated for years, that this isn't something that's new. Do you have any thoughts in that regard?

Ms. DE BRAGA. Thank you, Senator.

I think that's a real possibility. I spoke to that a little bit in my testimony. I personally know of three other cases, but we also have somewhat of a transient population. So there is a good chance that there are cases that were diagnosed elsewhere but that have their basis here. I heard from a lady who lives in San Diego, and I spoke about that in my testimony as well. She's not included in this present cluster. However, I think we need to expand that, because I think that there are more cases and more marrow diseases.

Senator REID. Is this San Diego woman sick?

Ms. DE BRAGA. No. She had a baby in San Diego. They moved to the base in Fallon when the child was a month old, lived here for over 3 years, and moved to Japan when the baby was 4. He died when he was five. She said—and I didn't know whether to laugh or cry—she said, "You know, when my son died, I thought God wanted him and that was why he died." And she said, "After reading this, the environmental possibilities, I'm not so sure." And what she wanted to tell me about was mosquito spraying when she lived here, the fogging that was done, and she thought, after reading a lot of this, that that was a real possibility. There's a lot of stories out there that——

Senator REID. That's interesting, Marcia. There was a lawyer in Las Vegas, a young man doing very well. He spent most of his time—I just thought of this as you mentioned this. He was a Mormon missionary in New Zealand, and he and his companion were walking, and there was heavy spraying taking place and they were sprayed, and his family felt that's why he died at such an early age. I don't know if it has anything to do with that or not, and maybe Dr. Prescott can tell us.

Also, would you give me your thoughts about—you've spent as much time as anyone else on this issue, and I'd like your thoughts as to what aspects a cluster investigation would most benefit from the involvement of the Federal Government. Do you have any ideas?

Ms. DE BRAGA. I'm sorry, what aspects of the——

Senator REID. What do you think the Federal Government can do, in your layman's opinion, to help with this investigation?

Ms. DE BRAGA. A lot, because I think there are a lot of resources through the Federal Government that aren't available to us in the State of Nevada, and I think that was just demonstrated here this morning, that there are a lot of resources. I think that when you're limited in the amount of data, research, and experts that you have available to you, it narrows the scope of your investigation, and I think that's where the Federal Government can play a huge part. I'm not just talking about any dollars that are available, I'm talking about the new knowledge that's out there, that's going to speed this up and help us to find a cause.

Senator REID. Marcia, one of the other problems that I face, Senator Ensign and all of us up here face, is the delicate line we walk between what Brenda Gross wants and the fear that is around in the community generally. Does what we're doing here have an adverse impact upon the community? As you know, Senator, the work that you've done in this regard, it's a real delicate line that we walk. What is your comments? Has what has taken place regarding this investigation been damaging to Fallon?

Ms. DE BRAGA. I've heard a lot of people say that, yes, it has, that we don't want this attention, that focusing on—and I think somebody mentioned it this morning—the negative aspects hurt real estate sales, those types of things. Of course, we don't want our community to have a bad image, but I don't believe that's—I would rather live in a place that cared more about its children than it does its image and that it's being proactive, fixing the things, whether they are the direct cause or not, so that they're doing everything that can be done to protect children. So the economy slumps a little. I don't personally believe that's the case. I think the attention that's focused here is absolutely phenomenal. We can go along pretty complacent and say, "Oh, my gosh, this is sad", but unless we make a real aggressive effort like is being done here, like Brenda commented on, we don't draw the attention and we don't get the forces moving to solve the problem. So I think maybe we have to give up a little, but I'm not sure that's true. I think this is the kind of image we want, that this is a community that cares more about its kids.

Senator REID. I'm confident, in the long run, that we'll be here.

I'm going to hear now from Senator John Ensign. What those of us in Nevada tend to forget is that this is Dr. John Ensign. Before coming to Congress, John Ensign was a veterinarian, and as we all know, the training of a veterinarian is very comparable to the training for a medical doctor, and he's been a big help in helping me understand some of the scientific problems we face here.

Senator Ensign.

Senator ENSIGN. Thank you, Mr. Chairman.

First, I want to say to both of you, obviously, our sympathies go out to you and we'll pray for your children. As bad as what you're going through, at least it's not 20 years ago. Our treatments today are much more successful. We have people like Dr. Prescott out there doing the research. So 20 years from now, it'll even be better. But, once again, it is important that we focus on the preventive aspects so children don't end up with this and we don't have them go through some of the treatments. Even though we're happy those treatments are there, they're still brutal for children to go through.

I want to also thank you, Assemblywoman de Braga, for the work that you've done on this. You've been a leader on this issue. I think your efforts should be applauded. I want to ask some questions of Dr. Prescott. One of them has been puzzling to me, because I hear reported often, in most of the reports I hear, "lymphocytic leukemia" and "acute lymphocytic" are mentioned yet, you mentioned "lymphoblastic." All the reports I thought used the term "lymphocytic." Can you address that?

Dr. PRESCOTT. They are pretty much the same thing. It's just a distinction based on the way that these white blood cells called lymphocytes look, and the children, in its acute form, usually have a less developed form of those cells. It can be either called lymphoblastic or lymphocytic. Adults typically have a much more mature—they may have a similar type of leukemia, but they have more mature white blood cells.

Senator ENSIGN. Are you aware of other clusters or how many clusters are discovered throughout the world, let's say in the last 30 years, and how extensively they have been studied?

Dr. PRESCOTT. I think there'll be other experts much more knowledgeable than I am about this, as that particular area—the epidemiology of clusters—is not my expertise. I can't answer that. Very many is the answer, but I can't tell you precisely. I can say that, unfortunately, as I believe you alluded to earlier, none of them have yielded a specific cause, the investigations of it.

Senator ENSIGN. Have we ever come up with a cause for any of the leukemias?

Dr. PRESCOTT. Yes. In some of the adult forms of myeloplastic leukemias, there's certainly a much stronger correlation with some types of bone marrow toxins in those cases, but it appears to be not the case, at least thus far, with ALL.

Senator ENSIGN. When you were talking about the genetic pathway, who would be in charge of investigating this genetic pathway, and who would be responsible for coming up with the protocol for making sure that this is consistent? Where can we come up with some information?

Dr. PRESCOTT. Excellent question. At a national level, it's being done by the Children's Oncology Group. This is an organization that includes all of the major cancer centers in the United States, and most children with cancer, including leukemia, are treated in major centers. That's because—although that 2,400 is a large number if it's your child, that's a relatively small number compared to, say, breast cancer in the United States—the expertise to care for those children typically resides in large urban centers, and so most children get referred there quite promptly. I was thinking just earlier, with respect to Nevada, this creates something of a problem

geographically. If patients live in the northeastern part of the State, they would come to us, without a doubt. In the western regions of the State, I suspect they'd go to Oakland or UC Davis or maybe to Stanford. If they live in Las Vegas, they would go probably to Los Angeles.

So from the point of view of the State trying to understand the incidence rates of a cancer like this and the approach, it would be quite fragmented. I think there's a risk that you could miss something, because the children are referred in different directions, and we would argue for some rapid reporting mechanism of Nevada residents, even if they're getting their treatment outside of the State.

Senator ENSIGN. Right, but the question would be, first of all, do we have—we're trying to find out what's the best way for us to, maybe, direct the Federal Government. What's your recommendation as far as investigating these children and their genetic pathway to the potential causes?

Dr. PRESCOTT. I'd like to second the recommendation of the expert panel, and that is to establish a registry of these children and a mechanism here, since we know there's a cluster going on now. I would argue that a really important component of that is rapid acquisition of a blood sample that could be used for various studies—of course, with the consent of the families and the child, but if they consent to that, it could be rapidly put into the system. They exist in the Children's Oncology Group now. So that could be taken advantage of immediately.

Senator ENSIGN. Have those blood samples been taken from the children? In the acute form, do these genetic pathways change? Do we even know when they're in the acute form of the disease, versus farther down, maybe they're in remission? Would we still be able to identify their genetic pathway if they're farther down? Do we have these samples ahead of time, already drawn?

Dr. PRESCOTT. I can't answer that, because I wasn't involved in the initial investigation, but I'm sure that Dr. Guinan or someone can. But the answer to the second part of your question is that, in the cases where children have already responded well to treatment, then we would not be able to do the type of test that I just described.

Senator REID. Senator Clinton.

Senator CLINTON. Thank you, Senator Reid, and I want to thank the panel. I particularly want to thank both Brenda and Tammy for being here today. I know this is not an easy kind of experience for you, and I join John in wishing your sons well and all the other children.

I'm particularly impressed by what Assemblywoman de Braga has done and I am grateful that she took this issue on, and the kind of leadership that she's shown at the local and State level to leave no stone unturned is exactly the kind of leadership we need across the country. You responded to Senator Reid's question about the kind of help that might be useful in responding to the cluster that has been identified here. Have you given some thought and does the assembly, with the approval of the $500,000 for investigations and bringing the cancer registry up to the current, have specific suggestions about what we at the Federal level could do to as-

sist you in expediting what you're attempting to bring about with response to the cluster?

Ms. DE BRAGA. Yes. Thank you, Senator.

Again, both in terms of making available to our State or helping our State assemble the resources that are not available—readily available in our State, I think the Federal Government—because, obviously, there has been a lot of research already been done. This isn't the first cluster. One of the things that's unique about this cluster is it happened in such a very short period of time. So there may be something new to learn here, but I think it will take more funding, because our staff is limited, and it will then take some specific work on the part of either the present expert panel that's been formed or one like it, so that we can avail ourselves of the experts that are out there and the research that's already been done. Senator Reid, I think, said in a news article that we don't want to reinvent the wheel. So if we can start at a point that is past what's already known and rely on—and this is going to take a tremendous amount of help from the Federal agencies—then I think we can speed up this process. I think that's very important. We don't want what might be a readily findable cause to disappear because too much time has gone by.

I also think that we need some means of having a central repository for information, that it can be somehow up-to-date. That's critical, I think. I asked some health division people, if we hadn't brought this to their attention, how soon would they have found it on their own through the normal channels, and they said it would be at least 2 years. In 2 years' time, if there's a readily findable cause, more children will become sick.

Senator CLINTON. I think that—and I hope that the Fallon community will see this in the years to come—because if we are able to do what every one of the panelists recommended, then Fallon will have made a great contribution to preventing a disease in the future, because, clearly, we are now at a point, as I understand Dr. Prescott's testimony, where technologically we can really seriously engage in the kind of discovery that was beyond our means just a few years ago. The human genome project, the advance in information technology, the ability to correlate associations that we may find of interest but don't know whether they're causal, such as pesticide spraying or arsenic in the water, all of these things, we can now track much better than we ever could. So I think that, in a very important way, advances in determining how to prevent cancer could really be attributed to the extraordinary response in this community, and for that, I think the entire country and maybe even the world eventually will be grateful to Fallon, and I hope the people of Fallon will understand how important this is.

Senator REID. Brenda, it's my understanding you've been receiving phone calls—you and other parents who have sick children have been receiving calls from around the country from other parents who have sick children. Is that true?

Ms. GROSS. Yes, it is. I've gotten E-mails, phone calls, and letters with lots of information that's been very interesting.

Senator REID. Other parents have received the same types of communications; is that right, Tammy?

Ms. BEARDSLEY. Yes, lots.

Senator REID. This is more than one or two E-mails or phone calls; is that right?

Ms. GROSS. Yes.

Senator REID. If you added them up, the 12 families who have sick children, it would be dozens and dozens of people who have made contact with you?

Ms. GROSS. I'm not sure on the other families, but, myself, I have received dozens, several dozens.

Senator REID. Tammy, you've also received——

Ms. BEARDSLEY. I have received dozens.

Senator REID. I think that's important, based on what Senator Clinton has said. I think we have to have a better method, as Dr. Prescott indicated, of rapidly identifying these clusters, and when we find something that appears to be a cluster, I think we have to have some way of responding as quickly as we can, and we don't have that right now.

Dr. Prescott, in your experience, is it common for childhood leukemia to occur in clusters?

Dr. PRESCOTT. No, it's not. Most of them do not occur in that manner.

Senator REID. So this is an unusual situation, from your experience?

Dr. PRESCOTT. Absolutely.

Senator REID. You've indicated that in the past, when we've had these clusters, that we've been unable to find a cause. Now, you've read all the material that we've sent you regarding this and you understand we have arsenic in the water and you understand, here, we have a large agricultural community and whatever goes with that agricultural community, and we have a very large and important military installation here. Some people say there's a—some studies talk about a virus that can be communicated. Do you think that it is possible that there could be a combination of things that I've outlined and other elements that are available that could lead to environmentally causing this condition?

Dr. PRESCOTT. Yes. I think it's less likely that it's a combination of things, but I want to apply an important caveat. I'd like to know the answer to the question I posed. It may be unknowable in this case, but I'd like to know the answer to that. Do all these children have a common pathway to their cancer? If so, I would be virtually certain that there's something from the environment. Now, speaking from genetic terms—I would even include a virus in the environment or anything outside—I would surmise that it's more likely that it's one thing that affected all of them than a combination of 20 percent this, 40 percent that, but I'm just speculating. I don't know the answer to that, but I believe that to be much more likely or more probable. But you're right, in these cases, we know that many things—we know that viruses can cause cancers. We have many examples of that. We know that some environmental toxins can cause cancers. It's just the specific case of ALL where we've never been able to make a connection between those. Part of it comes back to this issue that I mentioned before—and I'm reluctant to say this in front of people who recently suffer with this, but it's a relatively uncommon disorder. We only have 2,400. It sounds like a huge number, but it's a very small number compared to the

other types of cancers we study. So we're often in this position of sort of scrambling after the fact trying to go back and say, "Gee, I wish I had a blood sample from a month ago, I wish I could test this or test that." There just aren't big enough numbers of cases and samples of blood or samples from the environment to make really robust associations so that we can really get to those root causes.

Senator REID. Dr. Prescott, having grown up in an era where—even though I lived in a very small rural community in Nevada, as a little boy, I was scared to death I was going to get polio. No one knew what caused it, but we knew that the disease was devastating and children like me all over America worried about this terrible disease. People in Fallon—even though this is certainly nothing comparable to polio, people here worry, Is this something I can catch, is this something that can be communicated from one person to another? What are your thoughts in that regard for the people of this community?

Dr. PRESCOTT. I grew up not being able to swim in the summertime as well, Senator Reid, because of the fear of polio, and I remember those days very strongly with some of my classmates who were afflicted with it. This is obviously a crucially important question from a public policy point of view, public health point of view, to try to reassure families where we can, and we need to do so in an honest and legitimate way. I certainly couldn't say to the people here that if there were a virus that did this, that we could be absolutely confident it's not still here somewhere. What I can say is that that's highly unlikely. First of all, there's never been such a virus described. We don't know if that's what the cause is or not, and we know historically, from these many clusters that have been described around the world, that they tend to be self-limited. So it would be really quite unprecedented.

I know that's an incomplete answer, but I think that one can be relatively optimistic that it won't continue, but we can't—since we don't know the root cause, we can't say for certain. Polio was different. Once we knew the type of virus and once a vaccine prevention was available, then we could approach that with a lot more confidence.

Senator REID. Senator Ensign.

Marcia, I join with the rest of the Senators up here on the issue of giving you great credit for your effort and your leadership in this regard, as I'm sure the community does as well and the families of those affected children. To the mothers that are sitting here, Brenda and Tammy, your contribution to this hearing is greater than you imagine. It's greater than—the fact that you sat there and told us about the trying hardship of your children. It's greater because we now have a greater empathy for this issue and a greater commitment to work on solving this problem. I have no questions of you. I just want to thank you for your effort, your courage and willingness to share with us your stories on this, and you do have our sympathies.

Dr. Prescott, I really appreciate your insight, because as you testified, it was as if a light bulb had gone on that we had for so long been looking externally for causes.

Dr. PRESCOTT. Absolutely. Adult leukemias also often have these translocations that I've described in my written remarks, which is where one piece of DNA from one chromosome gets switched over to another chromosome, and if that happens in just the right place to where the switch was made—there's a gene that controls the growth of cells—now we have a bad situation, where they begin to grow abnormally, and that absolutely happens in all types of cancer.

Representative GIBBON. Dr. Prescott, what can you tell us about clusters of adult leukemia?

Dr. PRESCOTT. There have been clusters of adult leukemia. It's not necessarily the case that you would assume there should be adults in Fallon with leukemia, because these diseases are so different. Adult types of leukemia are so different from childhood leukemia, and it would depend on what that external signal was. If it were something from the environment or an infection, it's perfectly plausible that it would affect only childhood leukemia or it would lead to an increase of breast cancer. We talk about cancer as one thing, but it's really at least a hundred things. It's probably on the order of several hundred things, if we get down to the absolute root causes of it. So it's not improbable at all that we would see childhood leukemia without adult leukemia. Just as in this cluster it's only ALL and not other types of childhood leukemia.

Representative GIBBON. Although our research and science into the trigger mechanisms lead us to look at the genetic sources that may be found, what other considerations should be raised, at this point? Are we focusing our effort too broadly? Should we be narrowing that effort? What is your opinion?

Dr. PRESCOTT. It's a question I like to be asked, as the former director of research of the Huntsman Cancer Institute. First, I'd say that Congress has been very generous to the NIH budget, funding basic research. There's always more that can be done, and I think the one place that we don't have an effective strategy in place is to apply some of what we've learned from the genome project broadly to clinical problems, I mean, really specifically. One thing that's often overlooked in that process is the clinical aspect of it, finding those patients quickly and obtaining proper samples, with appropriate informed consent and confidentiality, because we tend to focus on the very attractive high technology, because it's amazing what we can do with sequencing today. That's actually the part now that's simple to do, to be honest. It's simple to sequence the DNA.

The hard part is organizing a system so that you identify childhood leukemia cases rapidly, that you get those samples in the appropriate way, that you collect information about the treatment they had and the outcomes they had, and you can correlate that with the DNA sequences. That's the way that we're really going to unravel the basis of many types of human disease and get into an area that's sometimes called individualized treatment, which is what I was speaking about. We know that perhaps this type of leukemia might have six subsets and that one type of treatment will be better for one subset than the other, one type of treatment will cause more implications than the other, but if we can clearly get down to very precise typing, we'll do much better for the patient

with respect to curing the disease. This is true of all types of cancer.

It's a long-winded answer. I apologize. To get back to you, I would say that in a strategic sense, we don't yet have a global approach to how to do that, and I would argue that that's the next great leap forward, applying those DNA studies to understand human disease and leukemias in children.

Senator REID. Senator Clinton.

Senator CLINTON. I just wanted to add on to what the Congressman was saying, because I think what Dr. Prescott just said is so critically important. Would it be fair to say, Dr. Prescott, that it would not only assist us in better curing cancers by understanding more about the individual disease, but also in preventing it. The more information globally that we can collect and that we then use both for cure and treatment, we also—if we have the appropriate plan to do this—will be able to begin to, perhaps, find answers to some of these questions that, right now, we can't answer.

Dr. PRESCOTT. Absolutely. In the ultimate realization of this, of applying this information about DNA sequences and our genes and how we're predisposed to the likelihood of disease, the distinction between treatment and prevention goes away. If you could diagnose early—prevention is the treatment, and it absolutely is the great promise of this technology.

Senator CLINTON. One of the things that certainly strikes me, just as a layperson, without any of the expertise that Dr. Prescott obviously has, is that if we survey the way we're living—and this goes back to something that Tammy said, which I don't want to lose in the discussion. We are living very differently than our grandparents lived. Whether we live in Nevada or Arkansas or New York or wherever we're living, we're living differently, and in the course of that different living, we've had so many blessings that we're grateful for, but I think it is appropriate for us to take stock of what are some of the unintended consequences of the ways in which we are living, so that we don't overreact, but we also don't ignore changes that could be made that could keep us healthier longer. This is something that may not directly fall in the realm of science today, but without adequate research being directed toward determining—What are the environmental contaminants that we expose ourselves and our children to on a regular basis? What is the cumulative effect of those contaminants over time? What is the distribution of viruses? What's the assessment of exposure to things that we didn't really have in our homes or that we didn't understand the impact of?

I know that there are people who will say, "Well, but we've lived this way for a long time and we don't suffer any ill effects." I'm often reminded of meeting the 95-year-old smoker who says, you know, "I've smoked all my life. It didn't hurt me a bit." Well, that's a unique case, because we know it's hurt a lot of other people. Our genetic makeup may have protected us over time against some of those assaults, but the accumulation of the assaults may break down or find that genetic pathway.

So I think that, you know, we do have to ask ourselves these hard questions. That's one of the reasons why environmental health is, to me, the real frontier of where we go now in medicine,

because we've made so many advances. Now let's take a step back and figure out how do we prevent these things, not just enough that we can cure with extraordinary medical research childhood leukemias that are way beyond whatever was dreamed 25 years ago, but how do we change some of the environmental impacts or better understand the virus transmissions and the exposure assessments, so that we can prevent it, we can relegate it to the dustbin of history. I think what Dr. Prescott said, I hope, will inform the Congress. I'd like to thank this panel very much. It's been most illuminating, and I'm sure that the information we're going to take back to Washington as a result of this panel, alone, will have made our trip worthwhile. Thanks very much.

Senator REID. We're now going to hear from Dr. Mary Guinan, the Nevada State Health Officer. She has worked for the Centers for Disease Control and Prevention over 20 years and now leads our State's response to the Fallon leukemia cluster. She has extensive expertise and her relationships within the national public health community has given the State a unique access to assistance in conducting this cluster investigation. We're also going to hear from Dr. Randall Todd, Nevada State epidemiologist. Dr. Todd is an associate of Dr. Guinan and is responsible for the technical elements of the State's efforts. He's primarily responsible for developing many of the programs within the State. We're also pleased to have with us Rear Admiral R.J. Naughton, who's accompanied by Captain D.A. "Roy" Rogers, commander of the Fallon Naval Air Station. We also are going to hear from the mayor of the city of Fallon, Ken Tedford, who has worked with us so well and so hard in arranging for this hearing, and Ms. Gwen Washburn, who's the commissioner with the Churchill County Commissioners.

We're first going to hear from Dr. Guinan.

Dr. GUINAN. Senator Reid, I'm going to ask Dr. Todd to first give us a presentation of his findings. Dr. Todd has been the lead scientist in the investigation of this cancer cluster, the first phase of the study, and he will present those findings.

STATEMENT OF RANDALL TODD, STATE EPIDEMIOLOGIST, NEVADA STATE HEALTH DIVISION

Dr. TODD. Thank you. Good morning, Mr. Chairman and members of the committee. For the record, my name is Dr. Randall Todd. I am the State epidemiologist and work with the Nevada State Health Division. I'd like to briefly describe the Health Division's investigation into the cluster of childhood leukemia in Churchill County and discuss the role of Nevada's Central Cancer Registry assisting us with that investigation.

The initial phase of our investigation consisted of confirming the diagnosis of each reported case and conducting an interview with each case family to identify any potentially common characteristics or environmental exposures that might point to a preventable cause. I should mention that we're indebted to the Centers for Disease Control as well as the Massachusetts Department of Public Health for their assistance in providing us with model interview instruments.

The case family interviews were conducted face to face with each family. This involved a detailed review of the family's residential

history, from the date of diagnosis back to a point in time 2 years prior to conception of the ill child. For each residence, we inquired as to the source of water, in-home treatment of water, and uses of water. We also inquired about known exposures to chemicals from agricultural or home use of herbicides and pesticides, as well as indoor uses of chemicals and solvents. For each parent, we inquired about occupation and occupation-related exposure to chemicals, dust, or radiation. We conducted a detailed review of the child's medical history and the mother's pregnancy and breast-feeding histories. Finally, we asked case families about any hobbies, sports activities, or typical travel destinations that might have brought them into contact with chemicals, fumes, or radiation.

From this interview process we learned that half of the case families had spent 2 years or more in the Fallon area. The others had resided in the area for shorter periods of time. These 12 case families had resided in a total of 88 different homes over their respective time periods of interest. Of these 88 homes, 22 were located within Churchill County, and of these 22 local residences, half were served by public water systems, while the others obtained their water from domestic wells.

Our initial analysis of the occupational, medical, environmental, and other historical information provided by the case families has not suggested any particular common denominator that would link these cases together. We recognize, however, that some of our data is subject to recall limitations on the part of the families. Specifically, they may not have known of an environmental exposure that did, in fact, exist or they may have forgotten about it. For this reason, we are currently taking steps to obtain additional data through objective environmental sampling. This constitutes a second phase of the investigation.

We're now in the process of obtaining water samples from these current and former case residences in Churchill County that are served by domestic wells. These samples are being subjected to the analyses that are routinely done for public water systems. In other words, any test required by the safe drinking water act for public water systems is also being conducted on the water samples obtained from the wells of residences where case families have lived. The results of these analyses are pending at this time.

We've also invited the Centers for Disease Control and Prevention, as well as the Agency for Toxic Substances and Disease Registry, to assist us in identifying and analyzing completed pathways for other sources of environmental contamination. This would include industrial, agricultural, military, or other sources.

On a parallel tract with these environmental studies, we are also collecting data on the overall population dynamics of Churchill County. This includes looking at size of various age cohorts over the last 10 years, school enrollment information, and military populations. This analysis will help us determine if Churchill County matches the profile of other communities around the world where population mixing has been suggested as a possible explanation for increased rates of childhood leukemia.

In closing, I would like to make some brief comments as to the importance of cancer registries in the conduct of cancer cluster investigations. Nevada has maintained a population-based cancer

registry since 1979. This activity has been funded, in part, through a grant from the Centers for Disease Control and Prevention since 1995.

I should mention that all disease reporting systems, including cancer registries, do experience a lag in time between the diagnosis of a case and the reporting of that case. With a disease such as cancer, the patient record may not be complete enough to warrant abstracting information until about 6 months from the date of diagnosis. Additional delays in obtaining information beyond this 6-month time period relate to workload and staffing. In more rural parts of Nevada, this situation is made even more difficult due to the distances involved and the relatively low number of acute hospital beds in each facility, making it costly and time-consuming to collect rural data. For these reasons, if a cancer cluster is identified through a cancer registry, it's likely to have been going on for some time.

The increased incidence of childhood leukemia in Churchill County was not identified through analysis of cancer registry data. The local hospital, physicians, and community leaders noted the cases and perceived the numbers to be unusually high. Nevertheless, Nevada's cancer registry has been invaluable in helping to place the observed number of childhood leukemia cases in historical and geographic context. Only through this analysis of cancer registry data have we been able to calculate the usual rate of childhood leukemia and determine that the local cases do, in fact, represent a significant excess over the expected.

I'd be happy to entertain any questions the committee might have.

Senator REID. Dr. Guinan.

Dr. GUINAN. Yes, thank you.

STATEMENT OF MARY GUINAN, NEVADA STATE HEALTH OFFICER

I'm Mary Guinan, State Health Officer. I've been asked to speak today on the status of the continuing investigation and also Federal roles in the investigation of cancer clusters.

On February 15, after Dr. Todd had finished the first phase of the investigation and after the analysis showed no particular environmental or infectious agent that we thought was common among the cases and would be a likely causative agent, we asked a panel—we invited an expert panel consisting of experts from the Centers for Disease Control, the National Cancer Institute, the University of Minnesota School of Public Health, the University of California at Berkeley School of Public Health, and others, several from Nevada, University of Nevada School of Medicine, and we asked them to review all of the data and to help us plan the next steps of the investigation. That occurred on February 15.

The committee made six recommendations. The first was to expand case-finding efforts by seeing if you have all of the cases, are there other cases, and we're doing that. We're working with the Navy to see if there are any Navy families who have been through Fallon and whose children may have developed leukemia, and that search is ongoing, and Admiral Naughton will speak to that.

We also want to expand our case search with the Children's Oncology Group. Children's Oncology Group is a group of treatment centers around the country. As you know, cancer in children is rare, and we're very grateful it's rare, and so in order to get appropriate treatment protocols, the treatments are concentrated in groups around the country—California, Utah. We do not have one in Nevada. So the children with leukemia—over 90 percent of the children with leukemia in this country are treated at these children's oncology centers, and they have a data base. So what we want to do next—and we're waiting for the funds to do this—is working with—especially the California oncology groups—working with them to search their directories to see if we have Nevada patients who were diagnosed in those centers. We have no pediatric oncologist in Northern Nevada. So that all of the cases would be referred out. Most of the cases from Fallon are referred to California, and there is a pediatric oncologist that comes from California to Reno on a regular basis and continues their treatment, but the diagnosis is done in these oncology centers. So we will be expanding that.

The second recommendation was to categorize the ALL cases by clinically relevant biomarkers, and Dr. Prescott has mentioned some of those. What happens is, we need to really look at the leukemia tissue in order to do those studies, to look at the diseased tissue. So what we have to do now is to—many of the protocols of these oncology centers require saving tissue specimens. So we are going to be in the process of identifying each of the centers where the child was—where the bone marrow biopsy was done and what kinds of testing were done at that center. There are a number of tests that can be done.

The first broad test that's done is to identify two types of lymphocytes. Which cancer is it? Is it B lymphocyte or is it T lymphocyte? B lymphocyte cancer, or lymphoblastic leukemia, is much more common than the T cancer, and our cases reflect that. We have nine B-cell and we have three T-cell cancers. But there are subdivisions of that. In other words, each of the B cancers have subdivisions and very distinct analysis, which I think we need to move forward on, to see if those genetic breaks, those chromosome breaks are similar. Because if they're similar, then they're more likely to be linked to the same source, and that is a critical issue, that if we had known in advance and collected, we would know of specimens. We do not know whether we have those specimens available at the present time.

No. 3 was to identify potential excess environmental exposures unique to the community. Dr. Todd has told you that we're in the process of that. Next week, members of the Centers for Disease Control and the Agency for Toxic Substance and Disease Registry will be here looking at all of the environmental testing that has been recommended, seeing how we can approach that and who's going to do it and how we're going to do it, and also to do a pathways analysis to say, "If there are environmental chemicals that are toxic in the community, by what pathway do they get to people?" That's extremely important for us to analyze.

The next recommendation was to collect and bank biological samples for future study, and we are waiting funds for that. We need

to identify a repository for specimens. We would like to collect specimens from the families, as well as the cases. The technology is rapidly advancing, as Dr. Prescott said. So maybe in 2 months we might be able to have a test that would tell us something about causation. It's extremely important for us to save those specimens, and we don't have a national sort of comprehensive group looking at that, saying this is what we have to do for every cancer cluster.

The fifth recommendation was determine time course and characteristics of population movement into the Fallon area, and that's to address this population mixing theory, which was—it is just a theory, which came out of Britain after an investigation of a number of clusters, and that is that a rural population has an influx of people and, for some reason, there's an increase in leukemia or cancer in that community, and the reasons for it are very complex. In Fallon, that particular scenario may exist. In other words, that we have a small town relatively isolated and then the in-migration of various groups, either through the military or others, that come and go. So this is a possibility to test evidence for this population mixing theory, which go well beyond what the State of Nevada would do, but something that the National Cancer Institute should be doing, identifying and—there is no mechanism for the National Cancer Institute to give us funds for research. Their budgets are to study months and years in advance. So it's really important for there to be a comprehensive plan, as we suggested, for a study to advance the causation theory.

The last recommendation was to maintain the expert panel, which they have.

Now, about the lessons learned—all of the panelists serve without—we do not pay for them, they volunteer. They're wonderful experts, and we have been really blessed to have their interest, and they are volunteering to be here and help us, and they have done a tremendous job. One of the lessons that we have learned with regard to Federal agency roles in the investigation of cancer clusters, although hundreds of cancer clusters have been recognized and investigated during the past 30 years by State and local health departments and Federal agencies, little information is available on appropriate scientific methods of study, especially with regard to determining the causative factors or associated risk factors. Well over 90 percent of these investigations have found no associated suspect causative agent, and no Federal agency wants to expend scarce resources for the investigation of cancer clusters that are likely to show nothing. It's an investigation which you know that 90 percent of the time you will not find anything. So there is a reluctance to invest resources in something that has such a low probability of an outcome of interest.

Senator REID. Ms. Guinan, I think we're going to ask you some questions and you'll be able to expand on the rest of your statement. I'm going to make your entire statement a part of this record. You've answered one of the questions the panel already asked directly. We asked Assemblywoman de Braga about what the Federal Government can do, and you've told us very specifically. I would also just comment that 90 percent is great, but if you're part of the 10 percent, you want to make sure that's investigated also.

We're going to turn now to Admiral Naughton. I would say, before you begin your testimony, to explain to Senator Clinton and some of the audience who may not know, which I'm sure there are very few—Senator Clinton, in Nevada, we have two very large military installations, of which we're very proud. In the southern part of the State, we have an air force base, Nellis Air Force Base. It is the largest fighter training facility the air force has in the world, and I'm told by everyone, most important, if you want to have a Ph.D., so to speak, in the air force and be a pilot, you have to go through Nellis. The same applies if you're a Navy pilot. We have here in Fallon the Fallon Naval Air Training Center, which is something we're very proud of. Top Gun is here. It's something that has been great for our State, but also certainly for our Nation.

We recognize how important it is to the State of Nevada, but we're going to have some tough questions to ask when we get to the part of this hearing when we ask questions. Admiral Naughton and Captain Rogers has been through a lot of things in their careers, and they understand we're only trying to get to the bottom of things. We're going to ask questions about when you weren't even at the base. So my point is, the directness of the questions has no bearing on how important we feel your work is here.

Admiral Naughton.

STATEMENT OF ADMIRAL R.J. NAUGHTON, FALLON NAVAL AIR STATION, FALLON, NV; ACCOMPANIED BY CAPTAIN D.A. "ROY" ROGERS, COMMANDER

Admiral NAUGHTON. Yes, sir.

Senator Reid, Senator Clinton, Senator Ensign, and Representative Gibbons, my name is Richard Naughton. I'm the commander of the Naval Strike and Air Warfare Center, which is located at NAS Fallon, NV. Here with me this morning is Captain David Rogers, who's the base commander. We do welcome this opportunity to testify before the Environment and Public Works Committee on the military activity that takes place in Fallon, in particular, how it may pertain to Churchill County's recent childhood leukemia cluster. I'll talk a little bit about the background that the Senator talked about, about the mission and operations at Fallon, followed by some remarks that I know are of special interest to the committee, and we look forward to your questions afterwards. Let me assure the committee and the local community members that the U.S. Navy is committed to public health and to assisting this investigation in every way possible.

One of the cases in question is the child of a military family member who was formerly stationed at Fallon. Our base population is about 7,200 personnel, which includes all the military and civilians and their families, and of that 7,200, three quarters live in the local community. So we're very involved in the local community and we want to be sure that we're part of this solution. The Navy's Bureau of Medicine has just completed extensive screening of naval medical cases, which might be related to the Fallon cluster. They reviewed over 12 million records looking for cases of ALL from 1997 to the present, and just the one Navy case that I've already identified was the only one that we came up with.

The Navy is also committed to exploring the expert panel's population theory—population mixing theory, and we have shared data on the transient activity of NAS Fallon with the State. This military data is one of the three transient data collection efforts recommended by the expert panel.

As many of you may know, NAS Fallon began operation in 1942 as an Army Air Corps base. The focus at that time, until about 1984, was unit level air-to-ground combat training. When the Navy established the Naval Strike Warfare Center in 1984, we began focusing on entire air wing training of about 1500 people and 70 aircraft in an integrated fashion. The mid-eighties also saw the development of the Fallon Range Complex, an instrumented military operating area flown over 6.5 million acres east of Fallon. The majority of the land we fly over is unpopulated and managed by the Bureau of Land Management. The Navy actually only controls 204,000 acres. The third major change in the mid-eighties was the out-sourcing of many of the functions on the base. As a result, 55 percent of our current base population is civilian contractors.

In 1996, with the closing of NAS Miramar and the Base Realignment and Closure Act, all graduate level aviation flight training moved to Fallon, with the arrival of Top Gun and Top Dome from southern California and the establishment of a senior two-star officer on the base as the commander of Naval Strike and Air Warfare Center. As NSAWC, or Naval Strike and Air Warfare Center, I report directly to the chief of naval operations and provide oversight of the training of approximately 55,000 personnel a year here at Fallon and at our weapon centers and weapon schools at other fleet concentration areas throughout the United States. Over the past 5 years, flight operations have really only increased about 4 to 5 percent at NAS Fallon, with an average of about 40,000 flights per year. There has been an investment in Fallon infrastructure at NAS Fallon since 1984 of over $300 million.

I would like to discuss the specifics of our operations out there, as they may affect this investigation. First, the consolidation of all our training here in 1996 did not appreciably change the way we conduct operations. As a matter of fact, our two biggest years of operations at NAS Fallon were in 1990 and 1991, preparing for Operation Desert Storm and Desert Shield. From an environmental perspective, the flight training that NSAWC conducts has changed very little in the past few years.

Second, NAS Fallon's environmental, safety, operations, and weapons departments are responsible for the administration of all our environmentally-sensitive material. For anything we use, there is a safety handling program and a way of disposing it properly, where applicable. We follow the guidelines established by Federal, State, Department of Defense, and U.S. Navy agencies and are probably more heavily regulated than anyone in the private sector. Programs such as our fuel handling, air emissions, hazardous material disposal, electromagnetic radiation effects, and installation restoration are all inspected on a regular basis. We have received high marks for compliance, and we've shared data on each of these with the State Health Division and the expert panel. Next week, when the Agency for Toxic Substance and Disease Registry visits, we will share our data with them also.

Third is NAS Fallon's drinking water supply for the 3,000 personnel who work on the base and the up to 2,000 transients that we have there at any one time. It is separate from the city of Fallon's, but it taps into the same Basalt Aquifer, and the water chemistry is essentially identical. The base tests our water supply routinely and monitors for contamination of the 8,000 acres of the air station property through the use of 218 environmental monitoring wells. No DoD activity-related contaminants have ever been detected in the Basalt Aquifer or leaving the base property. While the State and select panel investigations have not established a link between Fallon water arsenic levels with the leukemia cluster, these are a matter of concern to our people and to the U.S. Navy, and we're working very aggressively with the city to build a DoD/city of Fallon water treatment facility.

My detailed written statement previously submitted contains lots of information about NAS Fallon and it may be relevant to this investigation, and it also lists points of contact. I thank you for your attention.

Senator REID. We would also order that that be made part of the record.

We're going to now hear from the mayor of the city of Fallon.

Mayor Tedford.

STATEMENT OF HON. KEN TEDFORD, MAYOR, FALLON, NV

Mayor TEDFORD. Thank you.

Recognizing that my time is brief today, let me begin by saying that the city of Fallon sincerely appreciates the efforts of the Senators and the Congressman and your staffs, just as we appreciate the help that we've received from the Governor's office and also from the State Health Division.

These are trying times for our community, and while we've pulled together in the only way we know how, it is comforting to know that others want to help. I'm not going to spend any time discussing the cluster's cause or possible links between the children. I believe the State Division of Health and others will do that. The city has cooperated in every way we know. First, as the steward of the municipal water system and, later, as we began to assess other city-owned facilities. Thus far, nothing has been found. We recognize that the health division's expert panel believes that an environmental link may not be found, due to the fact that the ALL found in this cluster generally is not typically caused by environmental triggers. Nonetheless, we will continue to cooperate in that search in any way we can.

Our efforts, indeed, have been focused on the children, the affected families, and public education. The city council and I have formed a group called Fallon Families First, which is comprised of local community leaders and social service providers to coordinate these efforts. I asked my wife, Jennifer, to chair that committee, and they're doing yeomen's work. Please realize that our city does not have a social service infrastructure. We're too small. So we've had to reach out to groups like the FRIENDS Family Resource Center, the local hospital, mental health professionals, the clergy, the school district, the county, and others. Fund-raising is handled through the Mayor's Youth Fund. You can see the white ribbons

worn by guests here today. This was a suggestion by a mom of one of the patients. It's the latest step in our effort, and we plan to continue raising funds as long as there are needs.

Fallon Families First recently held its first public meeting, a panel discussion focused on the disease itself. Local physicians, a mother of a stricken child, a mental health professional—these people, who people know and trust in our community, helped answer questions that are weighing heavy on the minds of those attending. Efforts like this will continue, as they are needed. A series of informational mailings is also being coordinated with the county and the local telephone company. This week, the city launched its first website. Part of this effort has been driven by not only the need to communicate about the leukemia cluster, but part of our desire was also to be generally more accessible.

So what remains to be done? I can tell you without hesitation that the most frustrating part of this process for me has been the lack of information. People want answers and I don't have them. The investigation's ongoing, but it's bound to take a long time. Where do people go for answers? I believe, in cluster situations like this, a clear sense of communication needs to be established early in the process. Perhaps if the State health officer declared a cluster to be in existence, that could trigger a Federal, State, and local partnership. The mayor's office seems to be the place where people automatically go, but in small towns like ours, we don't always have the information people want. I have assembled my own team of local citizens and other experts who can help the city, but in other towns, the mayor might not be so fortunate. I think a standard support team should be made available to towns like ours.

Finally, I would be remiss if I didn't speak briefly about the arsenic in our water. I know the Senators are aware of this situation, just as I know the experts will testify that arsenic's probably not linked to this leukemia cluster, but the two things have become linked in the media and in earlier meetings. So I feel I, at least, owe you an update of where we are today. Fallon's municipal water supply contains arsenic levels of a hundred parts per billion. The USEPA has ordered us to remove the arsenic, which is naturally occurring here in Fallon. As you are well aware, the EPA standard has long been under review. It was 50 parts per billion. It was temporarily lowered to 10. Now it's back to 50. We have no idea where it will finally be set. But for the city of Fallon, it doesn't matter anymore. We are proceeding to treat and we will get there.

The city of Fallon, through its environmental engineering firm, Shepherd Miller, has begun pilot testing of the technology we will use to remove this arsenic. It appears that a filtration process called enhanced coagulation is working best. We will finish the pilot testing by the end of May, then we will design and site a treatment facility. Our goal is to have construction finished in time to comply with the EPA order, which gives Fallon until September 2003. This date is significantly earlier than any other public water system in America, and it's still not clear how much arsenic we will have to remove. Nonetheless, we are proceeding, and we are doing so without regard to cost or where the money will come from. We also have been in consultation with the U.S. Navy and their officials about a joint treatment plant.

My suggestion to this body today is that you make Fallon a test case. The issue of the EPA standard revolves around the best available science and the fact that there is no off-the-shelf technology to remove arsenic on our level at our municipal scale. Things like household reverse osmosis systems won't work on a system as large as ours. We believe that since Fallon is required to remove its arsenic more quickly than other municipalities, there may be benefits to those who follow from learning what we have. Perhaps the Federal Government could pay for the cost of our treatment facility in exchange for the availability of science and treatment methods resulting here that could be utilized by all those who follow. We're dedicated to treating the city water. Others will have to address the many private county wells that have high arsenic levels, and all of us will have to address public education issues and outside media attention that now surround the arsenic. But with your help, we can put this chapter in our history behind us and focus all of our energies on this leukemia cluster, the children and their families.

We must maintain our focus on these families. As I've said earlier, this is a lonely time for our town. Many people want to speculate, many others are well-intentioned in their scrutiny, others are just curious, but when the camera lights are off and the media attention fades, our families and our town will be left to care for these children and assess the long-term impacts of this cluster on our community. Your presence here today is a chance to change that. I hope you will be able to stick with us, and I thank you very much for taking the time to be with us today.

Senator REID. Thank you very much.

Commissioner Washburn.

STATEMENT OF GWEN WASHBURN, COMMISSIONER, CHURCHILL COUNTY, NV

Ms. WASHBURN. Good morning, Senators, Representative Gibbons.

I'm Gwen Washburn, the chairman of the Churchill County Commission, and I want to tell you that we've not had the phone calls, I'm sure, that the mayor has, but we've been working closely with him. I do want to tell you that the county administration is, first and foremost, concerned about the health and well-being of its citizens, and I'm happy to have the opportunity this morning to address the leukemia cluster that's been identified in this community and also to discuss ways to investigate or mitigate the issue. I'll tell you a little bit about Churchill County and what the county commission is doing. You have several pages of written material in your packet, and I'll attempt to summarize those at this time.

Churchill County has sustained a steady growth of about 3 percent over the years and now is home to about 26,000 people. This population is expected to double in the next 15 years. We're a progressive small community, boasting modern schools, a community college, an art center, and the most modern hospital in western Nevada. We have a mix of long-time agricultural-oriented families, military personnel, young working families, and retired people. Many people are born here and grow old here with nothing more

than average health problems. So, our community is alarmed and feels helpless in the face of a childhood leukemia epidemic.

This community has reacted to this crisis in a quick and calm manner, working cooperatively together with all agencies in an attempt to find an answer or a common link between the cases. The county commission is very concerned about the health and welfare of not only our 26,000 residents, but those that visit us each year as military personnel or tourists. Certainly, none of us are experts in the health field, nor are we research scientists. So we have no choice but to leave those investigations to those experts, but what we can do and have done and will continue to do is to support all scientific and responsible efforts to find the answer. So far, we've actively participated in all efforts of all the agencies in the investigations and in the efforts to educate the residents and to ease the burden of the affected families. We've assisted in reactivation of the University of Nevada's Nevada GOLD Program, which is Guard Our Local Drinking water, and we've also tightened some of our own business permit ordinances for business and industry.

We are anxious to locate and take reasonable and responsible corrective action for any environmental cause that may be found to contribute to the incidence of leukemia or any other health risk in our community. A thorough and scientific study of all the possibilities will take many years and millions of dollars. The medical experts have already expended many resources examining the patients and their families. The community and individuals have all lent their support. The State of Nevada is considering committing money. So now I will ask you, on a Federal level, to commit Federal resources, and there are many, but I'm going to list ones that I think at this point are most important. No. 1 is to provide a funding mechanism to assure proper medical care for the victims; No. 2 is to assure thorough scientific research through Federal grants; No. 3, grants to the University of Nevada-Reno and Churchill Community Hospital to assure continued public education on health and nutrition; and No. 4, to assist individual well owners with testing and treatment of water. Best guess, this community has 4,500 domestic wells that our citizens are relying on.

The written comments that you have before you will expand on these thoughts and cover several others. So for the sake of time, I won't go into all those comments, but I hope you'll take the time to read and consider those, and I'll be happy to clarify and expand upon any of those at your convenience.

On behalf of the Churchill County commissioners, I want to thank you for taking your time to listen to our concerns and our ideas. We sincerely hope that you'll be able to assist our community in some way to ease the suffering of the leukemia victims and their families and to help us find the ways and means to lessen or, better yet, prevent more occurrences of this and other cancers.

Senator REID. Thank you very much. Your full statement will be made a part of the record.

Before moving to questions of this panel, I would like to say to those people who filled out the forms for asking questions of the panel, if you'd be kind enough to pass these cards to the center aisle, they'll be collected, so they can be given to us following the third panel.

Dr. Guinan, we've heard testimony about the possibility of this being a virus. Now, there's no danger of this being transmitted—if a child has leukemia that, by chance, is caused by a virus, there's no danger of that child transmitting the virus to his friends, is there?

Dr. GUINAN. No, there is not, there is no danger. Leukemia is not contagious.

Senator REID. That's so important, that people here understand that.

Admiral one of the things I wanted to talk to you about, in the written testimony that you've given and other people from the Naval Air Station have given, you've indicated that in the last 5 years there's only been 40 gallons of fuel spilled, or words to that effect. I just want to make sure that the record's clear, because I can remember spending a lot of time out there 10 years ago relating to a spill of fuel. There was some dispute as to how much had been spilled, from a thousand gallons to 30 thousand gallons. We really never got to the bottom of how much that was. Also, during that same period of time, people came forward and indicated that there was fuel contaminated soil that was burned for 5 or 6 days in a row at the base. This spill and the other information is not part of this record, it's simply not there, and much information has been gathered up to this point.

I would like to have the Navy supply whatever information you have to Dr. Guinan regarding these prior incidents. It's my understanding, and I've read very clearly the testimony given in the past, that this information has not been forthcoming in this investigation. I'll also say, Admiral, that I don't know if burning soil for 5 or 6 days would have any bearing. I simply don't know. I don't know if the fuel spill would have any bearing on the work that's being conducted here, but I think it should be part of the information gathering, so that Dr. Guinan and others will have this at their fingertips.

Admiral NAUGHTON. Yes, sir, we'll provide that, the data of the 1988–89 spills. There was lots of discussion on how much was or wasn't spilled, where it went, and I know there was much confusion. That's one of the reasons that we have these 218 environmental monitoring wells there right now, to be sure that there's nothing—there's no pathway off the base. We will provide that data.

The burning of fuel for 5 or 6 days, I think, perhaps is local legend, sir, but we will find out in much more detail. We can't find anybody that has any firsthand knowledge of that, but we will provide all that data. Again, as I say, our strategy is, we want—public health is our primary concern. We want to be part of the solution, and we will cooperate fully and provide all data humanly possible.

Senator REID. I appreciate that very much.

It's my understanding, Admiral, that the Navy has, during the past 4 or 5 years, used a different kind of fuel for the jet airplanes. Is that true?

Admiral NAUGHTON. Yes, sir. We've moved from JP5 to JP8.

Senator REID. Can you tell me why you did that and what the difference in fuels is?

Admiral NAUGHTON. Well, JP5 has—it's actually an economic issue—JP5 has a higher flash point and must be used on the ships. JP8 is the airforce-based fuel. It's almost all kerosene, with some additives. The only difference between JP8 and the jet fuel that's used in commercial airliners is that we have an anti-icing ingredient that's added to it. So it's essentially identical to what is burned in every airport around the world, including Reno-Tahoe.

Senator REID. Is it classified information, Admiral, as to how much fuel is used at this base over a year?

Admiral NAUGHTON. No, sir. We use about 40 million gallons, about 50 percent of what they use at Reno.

Senator REID. At the airport in Reno.

Admiral NAUGHTON. Reno-Tahoe, yes, sir.

Senator REID. The other question about the monitoring of the wells—and Dr. Todd, Dr. Guinan, you can chime in here if you feel it's appropriate. One of the concerns I have about the monitoring of the wells is that I've been told that there's really two areas of water that we need to look at here. The first is the deep water, and that's what's being monitored——

Admiral NAUGHTON. No, we're monitoring the shallow water. The deep water in the Basalt Aquifer is where we get our drinking water, but we monitor the shallow water wells.

Senator REID. It's the shallow, at least in my opinion, that we have to be concerned about——

Admiral NAUGHTON. Yes, sir.

Senator REID [continuing]. Because that water moves around.

Admiral NAUGHTON. That's the pathway that we're looking for, and we have not seen one—in the monitoring work between the Nevada Department of Environmental Protection, they are part and parcel of what we do there.

Senator REID. The water that you talked about, you have 218 wells that the Navy monitors, itself, as to where the water goes; is that right?

Admiral NAUGHTON. Yes, sir. If there's any contamination, we do test the deep water well routinely, just like the city does.

Senator REID. Senator Ensign.

Senator ENSIGN. Admiral, when they were talking about the mixing, I just thought about something. In your investigation, when you're looking at mixing of populations, we've heard about the possibility that maybe a virus is one of the environmental causes. During this period of time, when maybe some of the exposures of these children to some people in the community occurred, was there a certain part of the world that some of our service personnel came from? Have they looked at trying to isolate that? We know that there are very rare diseases in different parts of the world that Americans are never exposed to, and you can become a carrier without even knowing you were already exposed. We should look at all possibilities.

Admiral NAUGHTON. I'm afraid that it'd almost be an infinite set. You know, you talk about 50,000 people coming through here each year. We have been everywhere. Of my own personal experience, I've been on almost every continent. The people that come through here, it would almost be impossible to track where they each have been. I'm not saying that we can't look at it, but we can do some

analysis with CDC and the naval environmental health agency. We'll try and take that on, sir, but I'm a little nervous that it probably would be such a huge set of where they came from and what they did, and individually tracking each individual is not something that we do because of that, but we'll certainly look at it.

Senator ENSIGN. Dr. Guinan.

Dr. GUINAN. Yes. I'd just like to say that the theory on population mixing is one that suggests, perhaps, a viral cause, but it's not a new virus or an exotic virus. The theory is that it's a common virus and a mild virus that, for whatever reason, there's been an abnormal immune response to and that follows a community of relative isolation that has been exposed to the virus before and maybe are a little older and have a different response to the same virus. That's why it's so difficult to find, we think, because it's a common virus, but an abnormal response to the virus.

Senator ENSIGN. Has that community mixing theory, then, been mainly of cancers in older people and not in younger people?

Dr. GUINAN. No, it's younger people.

Senator ENSIGN. It is.

Dr. GUINAN. In England, there is a cancer cluster in an area that's been ongoing for years, and they have put millions and millions of dollars into investigation of causes, and nothing has turned up. I think one of those things—out of that observational analysis came the population mixing theory, and as I say, it's just observational and a theory, but the expert panel felt that we could provide evidence to support or refute the theory with the cluster in Fallon, for a number of reasons. No. 1, the timeframe between the cases was so short, that we are a rural population with an influx of migration, and also that, if we could look at tissue and demonstrate there was some similarity, the more likely we could possibly say a virus is more likely.

Senator ENSIGN. You were talking earlier about the B cells versus the T cells and that even the subtypes of the B cells being different in some of these cases. Does that not suggest different genetic pathways, or could they all be the same genetic pathway, and in the end, they branch off?

Dr. GUINAN. Well, I believe that for the B cells—if we thought they were linked and if they were all the same, we would be much firmer in our belief that they're linked. Since we really don't know what the cause is, we really don't know, but I think the lines of evidence suggest that T-cell may be a different type of etiology than B-cell, but the evidence is still relatively sparse, and as I say, there really is no known cause. So if we could come to, at least, some understanding of the pathway, we would be more likely to pinpoint a cause, whether it's environmental or infectious.

Senator ENSIGN. I want you to make one comment. It really has nothing to do with the particular case today, but it raises a question that we're dealing with in Congress where we're talking about all this epidemiology. When you're dealing with that whole issue, privacy is a big concern. We're hearing about reporting and trying to make sure—especially for cluster cases—to have rapid reporting. How do you relate that to the concerns for privacy and how do you protect people's privacy? We have to make policy concerning pri-

vacy, but at the same time be able to share information to be able to solve some of these cases in the future.

Dr. GUINAN. That's a very important question, and I think that it's raised each time we ask that a disease be reported. As you know, the State has primacy in matters of health, and it's the State who decides—the State legislature—what diseases are reported, in what form. With cancer, there are many people who do not want to be reported, because they want privacy. All of the information that's reported on individuals to health departments is strictly confidential. Nothing about personal identifiers comes out of the health department. However, in small communities like this, people know who the people are and they're identified for fund-raising in the newspapers, but no personal identifiers are ever revealed, and that is one of the things that we have to do, and as a health officer, I have to maintain that confidentiality.

We have HIV reporting by name, we have all sexually transmitted diseases, we have cases of leprosy, tuberculosis, all of those are reported to us, so we can do the appropriate public health work that needs to be done around these diseases, and they're all done and we haven't had a break of confidentiality. In other words, we maintain it, we take it very seriously. We have to deal with it now electronically, since records are being transmitted electronically, and understanding how you can guard the privacy and confidentiality of records that are being transported over the Internet, there are large Federal looks at that, on how to protect the confidentiality of data.

Senator ENSIGN. Well, Dr. Guinan, we look forward to continuing to work with you on this type of issue. I know it is a big concern for a lot of people—to make sure they have their privacy, but at the same time, to recognize there are public health concerns.

Senator REID. Senator Clinton.

Senator CLINTON. Dr. Guinan—I don't know if I should say this here in Nevada, but I understand you're actually a native New Yorker.

Dr. GUINAN. Yes. Could you tell by my accent?

Senator CLINTON. Well, I also know that you've worked, in a very distinguished career, with the CDC and with Dr. Phil Landrigin—who's at Mount Sinai Hospital in New York—who is very concerned about many of these issues that we're speaking about today. Your written testimony is extremely enlightening and informative, and I want to, through you, thank the expert panel that served with you for putting in their time to come up with the recommendations that they've put forth.

Dr. Guinan, as someone who has been on the forefront of public health as you have and, I know, played a major role back in the early 1980's in identifying HIV, AIDS, and recognizing it as a new disease, what would be your priorities for us to take back to Washington? Because one of the things that I'm concerned about is that we really come out of this hearing with some real priorities that all of us can take back to our colleagues and tell them that this is a pathway for us to follow in trying to get a handle on some of these issues, because I think there are going to be more of them. Maybe it's going to be better identification, better reporting, whatever the explanation. I think we're going to have more and more

of these kinds of environmental health issues raised, clusters, and other kinds of incidences.

What would you ask us to do and how would you rank the priorities as to how we could respond to Fallon, but more generally to these issues?

Dr. GUINAN. Well, I have suggestions on two fronts. One is on cancer cluster investigations. It seems to me that there is no repository of information on this. There should be. We don't know whether the clusters are increasing, decreasing, staying the same, and we really don't know what the results of most of the investigations of these clusters are, because there's no mode of reporting, in other words, there's no reporting on them. Sometimes they get published, maybe years after; in the Woburn, MA case, for example, from the identification on the cluster of leukemia to the final report was 18 years. In the meantime, we cannot benefit from the ongoing information they have gathered and advance the science. There may be 10 leukemia clusters being investigated right now, but we don't know about them, and I think it's extremely important to know that. In other words, if there are similar clusters ongoing, are they related, is there some relationship?

So the epidemiology of clusters should be done, not with the idea that some Federal agency has to investigate each one of them, but that there is some repository of information that the States and local health departments can go to and know and be able to contact those other people and find out what they're doing and not have to reinvent the wheel, as Senator Reid has said, that we can start from the most recent scientific evidence and move forward, and we need resources and we need to be able to identify those clusters that have the most potential for advancing the science of causation—what are the characteristics—and then some money to be able to put the resources into those that are most promising.

With regard to environmental substances that are toxic, there is no standard surveillance system for environmental agents, and it seems to me that there should be. We're always being asked about environmental agents, have we collected information on air quality, water quality, food quality, who collects it, how do they collect it, and no agency or group of agencies have come together and said these are the basic units of environmental surveillance that every health department should have. We should have air, water, and these are the things that we should have. Many States have particular environmental health concerns, like Nevada, about radiation, that we should have our own system also, besides the core, and there is not this kind of thinking. There is the communicable diseases. We know that there are communicable diseases and everybody agrees that these are the diseases that we should report, but there's no agreement on environmental. So I think it's extremely important that some thought process go into it and then some funding of infrastructure for the States to be able to develop those systems.

Senator CLINTON. Thank you very much. That's very helpful.

Admiral thank you for your being here and for your service. This reminds me, back in my prior life, in the White House years, I was asked to head up an investigation into the Gulf War Syndrome, because we had so many service men and women returning from the

gulf with unexplained illnesses, and I met with a lot of those veterans, I met with a lot of the people treating them, and we've made a little bit of progress in trying to determine why apparently very healthy young people after their service—which really was of limited duration, thank goodness, because the operation was so successful so quickly—returned home with terrible rheumatic and other kinds of diseases. So this is not only something that concerns cancer, we have other concerns, and oftentimes our people in the military are on the front lines of a lot of these inexplicable diseases and conditions, and I appreciate that very much.

One of the things I was curious about, though—it relates to Dr. Guinan's point—is that just yesterday the EPA released its new toxic release inventory data. We're trying to get a better handle on what we do release into the air and what kind of emissions and other contaminants might be available in the environment. I was wondering, does the Navy and the other services report releases to DoD and EPA or just to DoD? Do you know that, Admiral?

Admiral NAUGHTON. There's a lot of things we report. We report the release of radio-nucleotides from our nuclear power ships to DoE and DoD, and we report our release of chemicals through DoD, and I, quite frankly, don't know for sure if we report to EPA. I would be surprised—if it's not, it goes through DoD, because, as you know, we're a pyramid structure and we all work for somebody. It would go through DoD, would be my guess on that, Senator.

You talked about the Gulf War. I'm very familiar with it. I commanded a ship that was in Kuwait City. One of the very first cases of Gulf War disease was an MS–2 that was on my ship. I don't know why. I spent all day on the bridge and I didn't get sick. He spent all day inside and he did. So I don't know. But we do report all of our emissions and it is collected and it is reported to DoD, and we work through the Navy, through the Department of Navy health organization on everything we do.

Senator CLINTON. Thank you.

Senator REID. Congressman Gibbons.

Mr. GIBBONS. Thank you, Senator.

Admiral I want to applaud you and Captain Rogers as well for your contribution, not only to this Nation in terms of making sure we are secure in our Nation's people and our interests abroad, but also your contribution to this community. The Fallon Naval Air Station, I think, has been one of the premiere institutions that this community has oftentimes relied upon for technology, for assistance, for help in times of emergencies or whatever, and I do want to applaud you for your effort to share the information with the Naval medical studies that you're undergoing in this regard. I think that shows that you're leading the way and that you're willing to be a working partner in the solution to this. As somebody who has also shared the technology of training in some of your facilities, I also want to thank you for being there when we needed you. It's always been very important.

I really don't have any questions for the Navy, other than the fact that I did want to say that my understanding is that JP4, JP5, JP8, all very similar, maybe except for, as you say, the flash point temperature at which they ignite changed, primarily due to safety.

Jet Fuel A, without the de-icing additive in it, is essentially the same as JP8.

Senator REID. Jim, I think you're just showing off now.

Mr. GIBBONS. I couldn't keep up with you guys in the medical field. So I thought I'd tell you where I do have some knowledge.

But, anyway, when you talk about fuel burned and the effect of having a military aviation operation and comparing it to Reno-Tahoe International, Reno-Tahoe does burn JP8, with the fact they've got National Guard airplanes there that burn that. So I think there's, you know, an interest there, but one which, I think, will fail in comparison to say that it is the effect of the operation of the airplanes that is a causal factor in that, unless we start seeing clusters in Nevada in other locations, whether it's McCarran, Reno, Fallon, due to the combustion of this fuel.

That would be a question I would ask Dr. Todd. Have you seen other clusters in Nevada like this that you've seen in Fallon?

Dr. TODD. No, we have no other clusters at this time of childhood leukemia. In fact, when I look at 1999 data statewide, I find only 15 cases of childhood leukemia reported throughout the State. If I go back over a 5-year period, I find only 53 cases reported statewide. So, clearly, that's well over half million 0- to 19-year-olds in my denominator coming to Fallon, with less than a thousand 0- to 19-year-olds in the county population. Having eight cases diagnosed in only 1 year is clearly significant. We've not seen that elsewhere throughout the State.

Mr. GIBBONS. Let me turn to the mayor and the county commissioner and thank them for their appearance here as well.

Mayor, I know that oftentimes we have read in the newspaper that the city of Fallon is dragging its feet with regard to dealing with arsenic removal, but I know you, I know the work that this community has done, and just for the record, would you help us by describing what the city has done in any effort with regard to moving forward on the arsenic removal?

Mayor TEDFORD. Well, as you know, the arsenic issue goes back to—I was a sophomore in high school in 1969, and the discussion that began then—I certainly didn't start it, but I will be the one that ends it in 2003, that discussion. I think I could go back to the compliance agreement with the State that we signed in 1990 that we would meet the permanent standard when it was set. There's a lot of history, I think, that doesn't really need to be gone through today, but it should suffice to say, when we heard around 1997 that this standard was finally going to be set, after 10 years of waiting, we formed an arsenic team with the city. They went to various venues around the country, to EPA-sponsored meetings on what the standard might be and what the technology was. We had been told that there was off-the-shelf technology that we could use, and after those meetings in a variety of places, we found out there was no off-the-shelf technology that could be used in a city of our size.

In 1999, we got a violation order from EPA, and in 2000, we hired Shepherd Miller of Fort Collins, CO, as our consultants, and they began the chemical testing of the water. They have gone through bench testing, they're at pilot testing now, as well as looking for site selection at the same time, as well as design. I think we're well on our way to being able to reach the mandate that

we've been given of September 2003. We've expended an inordinate amount of money for a little town. Just probably in the last year and a half, we've spent about $400,000 with arsenic and its study and its treatment, as well as expanding their work to include what's in our water that could cause ALL, of which they have not found anything.

So a lot has been done, but it's not an issue to us anymore. Actually in 1990, it wasn't an issue to us, because the city signed an agreement that we would do this. Politically, that might be a hard decision, because there are lots of people in this community who would prefer that we not do that, who feel that they're not being harmed by a hundred parts per billion of pentavalent arsenic, but that's not the decision we have to make. Our decision is to lower the arsenic by September 2003, and that's what the city council said to do and that's what we said to do, and we're going to do it. We're just looking at you all to help us fund that, so we can do it.

There are some issues with an interim standard, because we tried to seek out several funding sources, and with your help and Senator Reid's, we've been able to get about $950,000 for help with design and siting. We are trying to site that on property we own, to save that money. We've been able to get, through AB198, about $707,000. We have accrued about a million dollars since 1990 to set aside for arsenic. But the bigger problem is not just the building of the plant, but also the—what some people lose sight of is, we spread those dollars over 2,800 hookups in the city of Fallon. This new standard of 10—that's our goal to hit—really affects population sizes of 10,000 or less, as the Senator well knows from the recent legislation of Senator Ensign, where there is probably limited funds to do these sorts of thing. So this is an area where we—even though out in Fallon, we like to be self-sufficient, we're probably not going to be able to do that.

Senator REID. Mayor, there's no question that's the reason that Senator Ensign and I introduced the legislation 3 weeks ago. There are a lot of Fallons around the country. I agree with you. The standard has been set, and no matter what standard we set, Fallon has a problem. So we have to get rid of that. You were a sophomore in high school, I was a freshman in the legislature when this problem came up in the 1969 session, and we need to do something about it. If there is a thing that will hurt Fallon and the surrounding areas, it's this arsenic in the water, as far as growth. We've got to take care of that. Whether it has any impact upon this cancer cluster at this stage—we don't think so, but we certainly don't know—but regardless of that, we're going to take care of the problem, because, I repeat, there are a lot of Fallons around the country, and we need to provide money to allow this water system to be constructed. We're fortunate here in Fallon because we have this great military installation here, and there is simply no reason for the Navy to build a plant and Fallon to build a plant, we're going to do one together.

Mayor TEDFORD. We're fully supportive of that.

Senator REID. We hope sometime later this year to be able to have more than just "the check's in the mail."

Mayor TEDFORD. I think you're absolutely right. I think the cluster's heightened this and I think we've firmed our resolve that we need to do this.

Senator REID. We realize that Fallon is only a small part of Churchill County, and we're going to have to make sure that we provide some relief for the rest of the county, and that's something we'll talk about later. It may not be done here. We're not going to have a third treatment plant either. So we're going to try to do something to remedy this problem for the whole county.

One final question I have for you, Dr. Guinan. I don't want to ask any questions about epidemiology. I understand over 50 percent of Nevada Health Division's budget comes from the Federal Government. While the health division's total annual budget increased in recent years, do you have sufficient resources to devote to the cancer investigation and address all the activities for which the division is responsible? In effect, what I'm saying is, this must be a tremendous burden on your budget. Is that a fair statement?

Dr. GUINAN. Yes, it is a fair statement, Senator. The Governor has given us carte blanche and said we will provide resources to keep this a priority, but Dr. Todd has been taken away from all his other epidemiologic duties and spends his full time on the investigation, and he has an assistant who also spends full-time on this, and that takes away from all of our other—and I spend a great deal of my time also on it. We have a very small health department and we're a small State. This investigation takes a great deal of resources, and I can only say, we couldn't have done it without the Centers for Disease Control, who have been here since we knew about it, helping us with the steps and finding out, getting the resources that we need.

Senator REID. It is a factor in your general budget. About 50 percent of it comes from the Federal Government, in some form or fashion; is that true?

Dr. GUINAN. I believe it's 85 percent.

Senator CLINTON. Senator, could I just add one final thought to what the mayor was saying? Because I really appreciate what you said and the resolve that you've shown for resolving this problem, and certainly both Senators Reid and Ensign are going to stand behind you and try to figure out a way to get some resources to you. But I just want to reiterate what Senator Reid said, because our infrastructure needs for clean drinking water around our country and for waste water treatment are woefully underfunded, and part of the challenge we face is providing help through Federal resources to communities, such as you have here, so that you don't have to go it alone.

It is a very big issue that is really on the horizon. It's one of those issues that is not on the front pages of the newspaper, but if we stop and look at what we need over the next 25 to 50 years to make sure our drinking water is safe, to deal with problems like arsenic, to set a standard and stick with it, so that you can plan and know what you're supposed to be doing, and to deal with, in more populated areas, like the many that I represent, the waste water runoff that takes pesticides and all other kinds of contaminants, as well as sewage, into lakes and rivers and—I was, yesterday, on the Long Island Sound—because beaches that people used

to swim in just 10 years ago are now closed permanently because of pollution, because we don't have enough treatment for the sewage that is flowing in.

So I think that what you said in your original statement, Mayor, about Fallon being seen as maybe a model or a pilot project is something that we ought to take seriously, and we ought to find some other pilot projects around the country to deal with these infrastructure needs. At the Federal budgetary level, these are not issues that either individuals or communities can handle on their own. They really do take all of us to try to pull together to deal with problems that we know we have. So I really want to thank you for your testimony and for your response to the questions that have been asked today.

Senator REID. Senator Ensign.

Senator ENSIGN. I want to discuss something about possible areas of funding and getting more resources. I know we have heard once or twice about the way that the water system of Fallon water is a bit of an issue out here. We know that we have a Superfund site upriver on the Carson River, between the Truckee River and the Carson River since the beginning part of the twentieth century. At least, we have those two rivers coming together and dumping into Lahontan Reservoir. That was fairly standard practice, I guess, kind of a "flushing" type of, situation. We don't want to go into all the details of what's happened in the last few years, but there has been a change, in the way that the rivers flow. The question is: Is there a change in the content of those rivers where they come together? Can we maybe go after some of the Superfund money to possibly investigate the possibility? Is that a place where we could look for funding to investigate what's going on?

Dr. GUINAN. Well, luckily, Senator Ensign, you have the head of that agency who does the Superfund investigation, Dr. Henry Falk from the Agency for Toxic Substance and Disease Registry, on the next panel.

Senator ENSIGN. I guess we will ask that question to him.

Senator REID. Congressman Gibbons.

Mr. GIBBONS. Just one final brief comment here to the mayor and the county commissioner. We're all aware that you have the welfare of this community, the welfare of this county as your No. 1 priority. The No. 1 priority would be the health and safety of its individuals. The second priority, of course, would be the economic welfare of this community. There've been reports and people have called and said there's been an economic impact, because of the adverse publicity that this issue has given. We've heard testimony today, even Assemblywoman de Braga has indicated, that the No. 1 issue should be the welfare of these children. We all agree with that, but since there are reports of that, since you've probably heard the same statements, what can the community do, in your opinions, both from the county and the city perspective, with regard to dealing with the economic issues that are addressed here?

Mayor TEDFORD. Well, you know, Congressman, I believe there is an impact. There's no question. It just has not been, in the City's view, the foremost issue right now. As you say, it has been the families, but it is an issue that we know we need to get to. I hear from people—like Mrs. de Braga said—realtors that housing sales

are down, contractors aren't building houses. So you hear those concerns, and I think it is something that we, as a city, are trying to develop now. We're trying to gather information and knowledge and data from other places that went through these things, like what we're going through. We've even preliminarily planned to make site visits to some of those places to ask, "How did you handle your economy after you, hopefully, were done worrying about your families?"

So I really don't have a hard answer as to what I think we can do. I think we're probably going to need some sort of economic development money to spur—if there is a lag here—to spur growth back to where it was. But, in all honesty—and the press have asked me that question many times—it is not an issue I've spent a lot of time on, but that I plan on doing very soon, because that's a critical issue. It's no different than the families. I have four children under 10. So they're all in Dr. Todd's factor of 0 to 19. I have to be worried about every family.

Well, the same is true of business, and my responsibility is to every business in this community. So that, indeed, is a great responsibility that is going to take a lot of thought. I think one thing that—if I was thinking of moving a company or moving my family to a community, I would want to know, first and foremost, this community had a problem, it addressed it, it didn't deny it was there, and it helped those families that were suffering, and, to me, that would go a long way as far as easing some of the economic damage that's maybe being done. Commissioner Washburn may have a different take on that than I do, but I am hearing those same comments that I'm sure you're hearing too.

Senator REID. Commissioner Washburn, do you have anything to add?

Ms. WASHBURN. Yes. I agree that there definitely is an economic impact that has come with the notoriety that this issue has brought to the community. One thing that I think you'll find in my written portion here is that I've asked that there should be some Federal funding to underwrite some low-interest, maybe some longer term loans for the businesses that are being proven to be hurt by this. That is one possibility. We are attempting to help ourselves as much as we can. The Churchill Economic Development Authority is working very hard, and I've attended many meetings on this, on what we are calling a visioning program at this point, but we're exploring ways to put the community in a more positive light for people that are looking to put their businesses and small industries in this area, ways that we can attract those people and overcome this problem and make it a positive place for them to be. We are working with that. The other thing that comes to mind is just basic cooperation between the city, the county, neighboring counties, legislators on all levels. We just need that cooperation, and if we can all talk to each other, I think we can get through this and our business and industry can come back the way it was.

Senator REID. Thank you both very much. The whole panel has been outstanding. We appreciate your being as candid and forthright and informed as you are.

Senator REID. We're now going to hear from Panel III, Dr. Henry Falk, who is the assistant administrator for the Agency for Toxic

Substances and Disease Registry. We're going to hear from Dr. Thomas Sinks, who's the associate director for the National Center for Environmental Health, Centers for Disease Control and Prevention. We're going to hear from Ms. Ramona Trovato, who's the director for the Office of Children's Health Protection, U.S. Environmental Protection Agency. Finally, we're going to hear from Shelley Hearne, who's the executive director of the Trust for America's Health.

Dr. Falk heads the Agency, as I've indicated, for Toxic Substances and Disease Registry, serves under the director of the Centers for Disease Control. This was established in 1980 under the Superfund law for the purpose of studying and tracking the health effects of exposures to hazardous substances at Superfund sites and other hazardous waste sites and recommending interventions for public health.

Dr. Falk.

STATEMENT OF HENRY FALK, ASSISTANT ADMINISTRATOR, AGENCY FOR TOXIC SUBSTANCE AND DISEASE REGISTRY, ATLANTA, GA

Dr. FALK. Thank you very much, Senator Reid. Good morning to you, Senator Reid, and members of the committee. My name is Henry Falk, and I'm the assistant administrator for the Agency for Toxic Substances and Disease Registry, or ATSDR, as we've shortened it. Dr. Aubrey Miller, unfortunately, was detained by a snowstorm coming out of Denver and apparently will not be able to make it here this morning. I have spoken to him in advance of this session.

Thank you for inviting us to speak this morning. We share your concerns about the health and well-being of children and families in Fallon and across the country. Certainly, the testimony this morning was very moving, and it must serve as a spur to all of us in government to do our very best. We also share your desire to adequately address the concerns expressed about illness and disease that might be associated with the environment.

As you noted, our agency was created by the Superfund legislation. As such, we are an agency charged with determining the nature and extent of health problems at Superfund sites, including Federal Superfund sites, and advising the USEPA and State health and environmental agencies on needed clean-up and other actions to protect the public's health. ATSDR, of course, works very closely with the EPA through our Superfund responsibilities. We also work very closely with our DHHS sister agency, the Centers for Disease Control and Prevention, and, jointly, we will work with the Nevada Health Division to assist in investigating the cancer cluster in Fallon. For our part, ATSDR will assist in the investigation by reviewing all relevant environmental data for toxic substances and assessing whether people have been exposed to any of these contaminants at levels of concern.

Unfortunately, the cancer cluster in Fallon is not a unique situation. Increasingly, we at ATSDR are being asked by State and local health departments to help respond to compelling community concerns about apparent outbreaks of serious, noninfectious diseases with unknown cause. We work closely and collaborate with State

health departments and have been funding environmental public health activities in States since 1987. We currently fund programs in 28 States to assist in carrying out Superfund responsibilities, including cancer cluster investigations and activities related to concerns about hazardous waste and exposure to toxic substances.

The site work we do directly or through our State partners has changed somewhat over time. Our original mandate under Superfund called for public health assessments at all National Priorities List sites, and these constituted the great majority of our workload. While we still are heavily engaged at NPL sites, increasingly our site work now is also occurring at immediate removal sites, active waste sites, occasionally Brownfield sites, and, like Fallon, sites where communities, States, or congressional officials have asked or petitioned the ATSDR to participate in the investigation.

I know you are familiar with some of our activities through our work in Libby, MT, and Elko, NV, where individuals were exposed to tremolite asbestos through vermiculite mining and its effects, and I don't want to review all of that, but we were very actively involved in the medical screening of over 6,000 people and providing information back to them. In followup to remarks that were made on the last panel, we have been working—particularly in the Libby area, but also elsewhere—with local, State, and Federal health care providers to address health care concerns that arise, specifically to help local residents obtain medical care. We've worked closely with the Department of Health and Human Services' regional health administrator and other DHHS agencies, such as HRSA, to ensure appropriate treatment is available.

Such partnerships are critical to providing needed health services in such areas as Libby, Elko, and now Fallon. Partnerships are also critical to fully assessing the true existence and potential cause of disease clusters. ATSDR and CDC, in this respect, are reviewing and responding to the Pew Environmental Health Commission Report. The report recommends strengthening Federal, State, and local public health capacity to tackle environmental health problems and establishing a nationwide health tracking network for chronic diseases and related environmental hazards. We have made significant progress at ATSDR in developing registries of individuals exposed to specific substances, and we will work on the issues raised by the Pew Commission as well.

In keeping with the Superfund mandate to establish and maintain a national registry of serious diseases and illnesses, we at ATSDR see ourselves as having a direct responsibility under CERCLA to participate with CDC and others in developing disease surveillance or tracking systems, particularly for diseases with known or potential relationships to hazardous waste and toxic substances. Because of our close working relationship with EPA, we are particularly interested in the ability to link health data sets with environmental data sets.

We recognize that more could be done. The public naturally becomes concerned when they see situations such as half of a class of third graders needing to bring asthma inhalers to school or children suffering from cancer or other health problems. We at ATSDR are committed to doing what we can to address these very real concerns. We work every day at sites around the country to address

the concerns of communities affected by toxic exposures. We work with our colleagues at CDC to address the issue of health and disease tracking, and we continue to strengthen our ongoing partnerships with Federal, State, and local agencies.

On a personal note, just briefly, I started my professional career at CDC as a pediatrician in 1972. My first investigation in 1972 was of a leukemia cluster in Elmwood, WI. I did several such investigations over the next 18 months, none of which revealed an obvious cause for the clusters. However, my fourth or fifth such investigation was of four cases of liver cancer in a factory, which turned out to be the first reported cases of vinyl chloride-induced liver angiosarcoma in polyvinyl chloride polymerization workers. This subsequently led to much improved and safer working conditions for the entire industry worldwide. I have seen personally how agonizing and frustrating this work can be, but I also feel that if we are in the mode of carefully scrutinizing health data, then we will be positioned correctly to detect new problems as they arise.

This concludes my testimony. Thank you very much.

Senator REID. Doctor, I'm sure it's a comfort to the parents of the children who are sick here to recognize someone as well qualified as you doing the work that you're doing. So I'm glad that you're here.

We're going to now hear from Dr. Thomas Sinks. Dr. Sinks is a member of the State Health Division Expert Panel. He's already been of great service to the State health division. He represents other Federal agencies besides ATSDR. He's most active in assisting cancer cluster investigations and addressing environmentally-related community health concerns with the Centers for Disease Control and Prevention.

Dr. Sinks.

STATEMENT OF THOMAS SINKS, ASSOCIATE DIRECTOR FOR SCIENCE, NATIONAL CENTER FOR ENVIRONMENTAL HEALTH, CENTERS FOR DISEASE CONTROL AND PREVENTION, ATLANTA, GA

Dr. SINKS. Good morning, Senator Reid, and other members of the committee. I would like to say that I'm delighted to speak before you on this issue. This is an issue which is very important to many people, as can be seen by the media's attention and all the people here from the community.

I want to begin by assuring the people of Fallon and the parents whose children have been diagnosed with cancer that we at CDC are committed to the health and well-being of children. We are encouraged by the wonderful improvements in the clinical treatment of childhood cancers. Still, as has been said before, we need to identify the preventable causes of these diseases. Let me assure you, chance has never caused one case of cancer.

CDC has been providing technical assistance to Nevada since July 2000, and we will continue to do so, as you heard this morning. I won't go into the details of that. It's in my testimony. Perhaps someday we'll know how to prevent ALL, just like we know today that folic acid prevents neural tube defects. Whether or not we identify the cause of ALL, we need to assure the families of Fallon about the safety of their community.

I'd like to say a few words about cancer clusters in general. Public health agencies are challenged by the large number of public inquiries. Thousands of perceived cancer clusters have been reported. More than 2000 published newspaper articles from January 1990 to January 2000 contained the words "cancer cluster." A survey of 41 State health departments found that they registered about 1900 cancer inquiries in 1996 alone. Public health officials are expected to identify and remove the cause of each cancer cluster. Yet, only 10 percent to 15 percent of cancer clusters investigated actually find an excess of cancer cases. Of these, only a handful have led to discoveries of preventable causes of cancer.

Cancer clusters do provide an opportunity for cancer prevention and control. Cancer education and screening programs are important tools and can be used effectively in some cancer cluster circumstances. Occasionally, scientific investigations of clusters do lead to cancer prevention discoveries. I want to point out that most of these have come from the observations of clinicians working with patients. Another opportunity to protect human health occurs when a cluster coexists with a hazardous level of an environmental contaminant. In such circumstances, removal of the health hazard is prudent, whether or not it's related to the cluster. Cancer cluster activities in the CDC have included field investigations, a conference on clustering of health events, and technical assistance to health departments.

In 1991, CDC published a set of standard investigation procedures for investigating chronic disease clusters, and that has been distributed to all States and is available on the CDC website. CDC also funds State-based cancer registries, which is, in my mind, the essential tool for evaluating inquiries about too much disease. The Nevada Cancer Registry has received more than $1.4 million from CDC from 1994 through 2000. CDC also conducts exposure assessments and epidemiologic studies that evaluate how people are exposed to hazards and identify preventable causes of cancer.

I want to emphasize that State health departments are on the front line of cancer cluster evaluations, and being responsive to the public is the single most important element to this. Three additional ingredients to enhancing responses include infrastructure, scientific credibility, and coordination between agencies. Essential infrastructure elements are timely chronic and childhood disease registration and linking health and environmental data bases, recommendations supported by the Pew Environmental Health Commission. One significant advance is taking place with the creation of a national children's cancer registry through the Children's Oncology Group and funded by the National Cancer Institute. It will register all children with cancer at the time of diagnosis and collect specimens at that time.

Last month, CDC released the first national report on human exposure to environmental chemicals, providing baseline concentrations of chemicals in the blood and the urine of people in the United States. We plan to use this technology to assist the investigation in Fallon.

Scientific credibility requires staff at the State level having expertise not only in cancer, but also in epidemiology, statistics, toxicology, and other matters. Independent review by expert panels en-

sures the credibility of cluster investigations. Scientific credibility and direction could be further enhanced by directing priorities for future cancer cluster investigations based upon hypotheses for why cancers might cluster. A working group to establish such priorities is sorely needed. The successful collaboration in Fallon has not only included State health and environmental agencies, the CDC, ATSDR, NCI, the Fallon Naval Air Station, and researchers from the University of Berkeley and Minnesota, but also the willingness and interest of the people of Fallon and their appointed officials.

Thank you, Mr. Chairman and members of the committee, for the opportunity to testify before you today, and I'll be happy to answer any questions you might have.

Senator REID. Thank you, Doctor.

We're now going to hear from the director of the Office of Children's Health Protection, Environmental Protection Agency. Ms. Ramona Trovato is the director and one of the office's most experienced health officials. She will focus principally on EPA's activities relating to the effects of environmental pollution on children, including coordination with the Centers for Disease Control, the National Institute of Health, and the National Institute for Environmental Health Sciences.

Ms. Trovato.

STATEMENT OF E. RAMONA TROVATO, DIRECTOR, OFFICE OF CHILDREN'S HEALTH PROTECTION, ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, DC

Ms. TROVATO. Good morning, and thank you.

I am Ramona Trovato, and I'm the director of the Office of Children's Health Protection at the USEPA. I'd like to start by saying it's very distressing to me that 12 children in this community are suffering with leukemia, and my prayers certainly go out to them and to their families.

EPA's mission is to protect human health and safeguard the environment. We do this by controlling the amount of contaminants that go into the air we breath, the water we drink, and the food we eat. We can only do this in partnership with the States. We partner with them on both public health protection and environmental protection, and about half of our budget is sent directly to the States for their efforts to protect human health and the environment. This partnership is absolutely necessary, we believe, to address human health issues that are related to environmental factors, and it has to be a partnership at local, State, and Federal levels.

Today, I'd like to discuss the governmental efforts to protect children from environmental risks, I'll then give an example of how we responded in the past to a community problem, and, finally, I'd like to close by offering some thoughts about how we can work together to help in Fallon.

Over the last 4 years, Federal agencies have joined together to focus on three specific childhood illnesses that have environmental links. These are asthma, developmental disorders, and childhood cancer. Asthma affects about 5 million children and is the leading cause of hospitalization of children in the United States. Developmental disorders are the leading cause of lifelong disability, and

childhood cancer is the leading cause of disease-related mortality in children. Many of the factors that contribute to asthma, developmental disorders, and childhood cancer are unknown. Therefore, the Federal Government is focusing on research to better understand how these environmental factors contribute to childhood disease.

The EPA and HHS are funding eight centers for the first time to investigate the effects of environmental factors on children's health.

The National Cancer Institute is conducting a good deal of research into environmental factors that influence childhood cancer and is developing a national registry of children with cancer.

Congress authorized the Child Health Act of 2000, requiring a longitudinal cohort study, which is a long-term research study to examine the impact of environmental pollutants on children. As the Framingham study provided us most of what we know about heart disease, this study could be the watershed in understanding how environmental factors affect children's health. Where we have sufficient knowledge to act we have developed strategies to address environmental health concerns. These strategies are primarily directed to reducing asthma and lead poisoning in children in the United States. We're also working directly with communities and States to respond to their specific child-related health concerns. Currently, government agencies work informally together to address cancer clusters. State public health departments are the front line, and they go out and investigate first. If they want additional help, they contact CDC or ATSDR, and finally EPA may be contacted if they want an environmental assessment done.

In 1996, due to public concerns about high rates of childhood cancer in Tom's River, NJ, ATSDR and the State of New Jersey conducted a study. They found a contaminant in drinking water wells from a nearby Superfund site. This contaminant was identified by EPA, and we required the company responsible for that contaminant to put a carbon treatment system on the wells that were contaminated. There is no detectable amount of this contaminant in their wells at this time, and we are still conducting and overseeing studies to determine if this contaminant is a carcinogen and may have contributed to the cancer cluster.

Through the Superfund program, we work closely with ATSDR to respond to environmental hazards and associated health risks. Communities petition ATSDR for a community health assessment and they can request a preliminary assessment through EPA of environmental conditions there. If the environmental assessment indicates a problem, we can take steps to address that problem. EPA also helps communities address public health threats in drinking water through the Drinking Water State Revolving Loan Fund. This fund provides money to States for financing drinking water infrastructure projects. The program recognizes and emphasizes the needs of small systems, in particular, and those that serve fewer than 10,000 residents.

On a national level, I would like to suggest five actions to make environmental health protection a priority. The first is to formalize the cancer cluster response approach to address cancer, as well as other environmental health problems. Second, I'd like to see the

State and local public health infrastructure bolstered to respond to environmental health threats. I'd like to see a strengthening of the relationship between environment and health departments at all levels of government. I strongly support a national tracking system of chronic diseases. So we can understand where those diseases are occurring and, if possible, look for associations with contaminants in the environment. Finally, I think it's absolutely necessary to conduct this longitudinal cohort study to understand environmental factors that affect children's health.

Finally, I'd like to address how we at EPA can support efforts already underway in Fallon. We would like to work closely with the city of Fallon, the ATSDR, the CDC, and the State of Nevada to conduct environmental assessments. We can sample, analyze, model, and cleanup environmental hazards. In fact, EPA's Las Vegas laboratory has already offered to conduct analyses of chemicals that are not typically found in drinking water to help understand what else may be here. ATSDR and EPA have also established pediatric environmental health specialty units in nine locations around the country. These are a first. These units provide sources of information for doctors, nurses, and parents about environmental health threats and how they affect their children. In addition, these units will actually see children who have been affected. The closest one to Fallon is at the University of California at San Francisco.

Thank you for allowing me to address this committee and the community of Fallon. I hope that, together, we can make a difference and prevent this in other communities. I'll be happy to answer any questions.

Senator REID. We will get to some questions in just a minute. We're now going to hear from Dr. Shelley Hearne, executive director of the Trust for America's Health. Dr. Hearne has been involved with the Pew Environmental Health Commission. Last year, this commission issued a comprehensive report supporting enhanced tracking of chronic diseases in this country and the coordinated and enhanced capacity of the Federal Government to support cancer cluster investigations and to respond to environmentally-related community health concerns.

The most amazing thing I saw in your testimony is that you've been doing this for more than 20 years. So I think we should notify the Department of Labor for child labor violations.

STATEMENT OF SHELLEY HEARNE, EXECUTIVE DIRECTOR, TRUST FOR AMERICA'S HEALTH

Dr. HEARNE. I appreciate that comment, thank you. Thank you for this opportunity to come to Nevada and have a candid conversation about our Nation's ability to respond to clusters.

I do serve as the executive director of the Trust for America's Health, which is a new health advocacy organization committed to protecting the health and safety of our communities, and we are proud that several members of our advisory council are former colleagues of yours—Senator Lowell Weicker, Congressman John Porter, and also Congressman Louis Stokes. They strictly told me not to use the word epidemiology, you'll be happy to know.

Senator REID. I'm more happy than you can imagine.

Dr. HEARNE. I did recently serve as the executive director of the Pew Environmental Health Commission at the Johns Hopkins School of Public Health. It was a blue-ribbon panel charged with developing recommendations to improve the Nation's health defenses, and I appreciate all of my colleagues here from EPA, ATSDR, and CDC for their comments and thoughtful consideration of how to incorporate those recommendations in the agencies' activities.

No child or community should suffer like this, and my heart certainly goes out to the families of Fallon, but as a young health scientist, I am growing actually quite angry watching this story repeat itself across the Nation. As Henry Falk noted, Fallon is not alone. In 1997, there were almost 1100 public requests to investigate suspected cancer clusters in this Nation. My job as the last panelist, and I guess what holds us all before lunch, is to actually deliver some of the bad news, that our public health service is actually falling short in its duty to watch the health of this Nation, particularly when it comes to chronic diseases that may be associated with environmental factors.

We are seeing this all across the country. Back in my home State of New Jersey, parents in Brinck Township complained to health officials about a feared autism cluster. It took almost 5 years for the health officials to confirm a cluster of 60 cases, because no one tracks autism in this country. In Elmira, NY, 40 students have been diagnosed with cancer who attend a local high school. I can go on and on with stories. Chronic diseases account for 7 out of 10 deaths in this Nation, but we still have no adequate system in place to detect these diseases, nor the ability to effectively respond. Our health agencies only coordinate tracking infectious diseases, such as polio and typhoid, diseases that a national tracking and response system helped to eradicate in the nineteenth century. Over a hundred years later, we still have not updated our public health system. Our health specialists remain in the dark with no resources and unable to find the solutions to today's health threats.

Let me give you a few examples of what's happening here in Nevada. Birth defects are the No. 1 cause of infant mortality. Yet, Nevada does not have a birth defects registry, nor does Nevada track respiratory and neurological diseases, such as asthma and Parkinson's. Nevada's cancer registry consistently fails to meet national standards. Nevada is the only State that charges its hospitals as the only forum of reporting cancer cases. It's a perfect formula for poor performance.

See why I'm last?

The problem is, Nevada is not unusual. It's actually quite close to the norm. To solve this problem, the Pew Commission proposed a nationwide health tracking network. Here are a few of the basic components: First, we need to build on the existing infectious disease data systems that track priority chronic diseases and related environmental factors. This would include diseases such as childhood cancer, asthma, and multiple sclerosis. Next, we need to develop an early warning system that would alert communities to health crises, such as lead, pesticide, and arsenic poisoning. Third, we need to improve our response to identify disease clusters by coordinating health officials into rapid response teams to quickly in-

vestigate these health problems. Each State should have a chronic disease investigator. Most States, like Nevada, do not.

This network is the key to developing prevention strategies, which is the most effective way to reduce the $325 billion a year that we spend on chronic diseases. The estimated cost of a network is about 275 million, less than a dollar per person and about .01 percent of our expenditures on chronic disease. The NIH budget is being doubled. Yet, most of those dollars are not going to discover the most basic information about why these diseases occur, where they strike, and how to prevent future diseases. Ironically, the administration is proposing cutting almost a quarter of CDC's chronic disease program. Americans care immensely. Nine out of ten registered voters support the creation of a nationwide health tracking system, and even in today's economic climate, 63 percent feel that public health spending is more important than getting your money back, it's more important than cutting taxes.

Most local health departments have faced declining funding, inadequate training, and limited laboratory access. In addition, they receive minimal guidance from Federal agencies on identifying and responding to clusters. CDC and ATSDR must be directed to aggressively respond to communities like Fallon with modern tracking systems and investigators who can take action, and Congress must prioritize the real sources to make this happen. Without this kind of commitment, we're going to watch asthma, cancer, and other disease clusters grow and there will be many more Fallons, and perhaps that's the greatest tragedy.

Thank you.

Senator REID. Dr. Hearne, thank you very much.

Dr. Falk, I'll direct this question to you, but perhaps the other panelists could help. One of the things I'm concerned about and I've heard from the community is that this disease that has stricken these families leaves these families and the rest of the community without any real help to work through these problems. You know, if there's a suicide in a school, we have people trained around the country that come forward and help. Is there anything that we have on a national level to help communities like Fallon to meet the emotional needs that families have, in addition to their physical needs?

Dr. FALK. We at ATSDR do some of this around Superfund sites. We have very active community education programs. We work both with members of the community, as well as with professionals in the community. We even have programs with psychologists in the sense of stress management programs that we can do, when indicated. So we try to actually do that, but we don't do that beyond the Superfund program.

Senator REID. You acknowledge, though, that these families have a need in addition to making sure their kids get to a physician and take care of their physical needs. I think it's something that we have to keep in mind in this very complex society, that we have some resource we can call upon for this.

Dr. FALK. I think there are several aspects to this. Probably the most frequent question we see around hazardous waste sites is, How will we provide for medical care for those who are affected by toxic substances? As you know, as far as we are concerned at

ATSDR, our mandate relates to advising and studying public health issues, but we have no mandate or no authorization to provide actual medical care. What we are trying to do at the moment is to creatively partner with other HHS agencies to see whether existing Federal programs, whether regional offices of other Federal agencies can be applied to situations such as Fallon and elsewhere. So I think that we would like to see existing programs be able to be developed so they'll be applicable in situations such as this.

Senator REID. Yes, Dr. Sinks, please.

Dr. SINKS. If I could just add a brief comment. The day after I returned to Atlanta from the expert panel meeting, I received from Dr. Mary Guinan a request to identify resources to help the community deal with the mental health stress that they were having in terms of dealing with this extraordinarily difficult situation. I think it is a——

Senator REID. Were you able to identify any?

Dr. SINKS. We tried to look at the National Institute of Mental Health for resources. We do have a psychologist on our staff who deals with refugee health issues in the Third World, and Dr. Falk at ATSDR has a staff person who does help with Superfund communities on these issues and we linked her into the situation. I've not followed up to see where that is. I do know that there are some mental health professionals in the community working with members of the community.

Senator REID. It's obvious from watching the movie "Erin Brockovich," which was based upon a true story—I spoke to the lawyer who handled that case, and one of the big problems they had after they identified there was a problem there is dealing with the emotional problems of all the families that had, for many, many years, thought that their disease just came out of the sky someplace, when in fact it was Chromium 6 that was afflicting them. So, anyway, that's a problem we have to acknowledge.

I want to direct a question to you, Dr. Falk, or maybe Dr. Sinks. I'm fascinated by the studies that we have as to this maybe being a population mixing problem. There's no better example of this in Nevada than in Fallon, unless, perhaps, Nellis. We have people coming literally from all over the world, we have people staying here for short periods of time and leaving, and we have population exposures taking place here. What we heard earlier is that there simply is no method to do the tracking, and I'm wondering if you have a reaction to this—in fact, anyone on the panel, other than Dr. Sinks and Dr. Falk. Is there any way we could do a better job? I mean—and we've got the parents over here—we should find out about it, it shouldn't be too difficult to do. We should do it, if it's possible to do the tracking. Can we do this?

Dr. FALK. One of the things that I have noted over the years is that most clusters are identified by members of the community. Occasionally by physicians, but very often the people themselves recognize that a problem is occurring. We are remiss in the sense that somehow the health care data systems, or tracking systems, call it what you will, ought to be identifying these kinds of situations proactively and arranging to deal with them. I assume that many clusters are not even brought to anybody's attention, because there is no system that identifies them. So, yes, I think we could do a

much more organized effort to actually identify the distribution of cases, look for clusters or uneven distribution of cases where the rates are very high and actually explore those in a more systematic way and in a more uniform way.

Dr. SINKS. Allow me to add to that.

The Kinley hypothesis you're referring to is extraordinarily interesting. I view it as one of those hypotheses that we ought to be searching for and targeting for research. This theory is very interesting, but, we've not really come up with a way to scientifically put it to the test—prove it correct or false. Perhaps we might pull together experts specifically to work at that hypothesis and come up with a plan for testing. The second is that we fund extramural research through the National Cancer Institute. I think there is a role for extramural research in cancer clusters like this. There are wonderful researchers out there in the academic community, two of which are on our expert panel.

Senator REID. Senator Ensign.

Senator ENSIGN. Dr. Sinks, when we talk about clusters, statistically, what are we talking about here? What makes something statistically significant to become a cluster?

Dr. SINKS. I'm always troubled by the word cluster. I get a number of phone calls from the public, from the media, from States, a variety of places—and let me say that I really enjoy speaking to those people about their issues. The word "cluster" seems to be something that is defined differently from one person to the next. In my mind, in the simplest sense, it's the concept that we're observing more cases of some disease than we would expect to see, given our baseline information, which we hopefully have, and we do have that for cancer. For many of the cancers, we do have population——

Senator ENSIGN. But that's what I'm saying. Then at what level is it statistically significant?

Dr. SINKS. Well, this is the problem. Statistical significance simply implies the likelihood of chance. The likelihood of chance is very much influenced by the size of the population and the number of cases, and it's not as relevant on the likelihood of cause as other things. So I, myself, am not so hung up on what the *P* value is in terms of, is the probability one in a thousand or one in ten thousand? I'm more concerned about, are there things that make biological sense here in terms of a possible agent that people might be exposed to?

Senator ENSIGN. Well, isn't the reason—if it's possible by random chance—what Assemblywoman de Braga talked about, one in a quadrillion? I don't know if that's an accurate number, but certain parts are statistically impossible when you get to a certain level of a number.

Dr. SINKS. Well, Senator Ensign, I think this is the double-edged sword of looking at clusters. On the one hand, if we simply go out and try to draw circles around the population looking for events, we're going to find them. Whether the chance is one in a thousand or the chance is one in ten thousand, if we do a thousand searches, we'll find one. We have to be a little cautious, when we start drawing circles, that we have some fundamental understanding of why

we're drawing the circle, that there might be something that we're looking for.

I don't know if I'm answering your question.

Senator ENSIGN. Well, not really.

Maybe, Dr. Falk, you want to take a shot at this. Is this random chance? Obviously, I think this one is a fairly extreme case. We see such a small population, and the chances of this being random, I think, are pretty slim. When we look at other clusters as we're forming public policy, and we are not just forming public policy for Fallon—when we're developing these type of things, looking at other cases in the future, we need to know what is significant in the future. We want to know when to bring these resources to bear.

Dr. FALK. I think this is one of the hardest aspects of dealing with problems like this. If you think of tens of thousands or even hundreds of thousands of cases of cancer across the United States, given the distribution that may occur, even randomly, there would obviously be many occurrences by chance that look like they're unusual but may not be, and it's so very hard to know which ones to actually focus on. Sometimes, as you pointed out, the statistics are so striking, as here, that we say "Oh, definitely, this is where we should focus." But I think there's a huge gray area in between something that looks like a perfectly normal distribution and a situation such as we're discussing this morning, where there will be only two or three cases or seemingly unusual distributions, certainly ones that would seem so to people who are concerned. I think, as Dr. Sinks points out, it will take a lot of judgment to know where to focus and where the best hypotheses are to pursue these leads.

Senator ENSIGN. I would just suggest to you that this seems to be a fundamental question that we need to answer as we're going forward. Resources are not unlimited. If we are going to focus resources in the best possible manner, we are going to have to deal with this question. If we're going to have a national register or if we're going to have a focus, at what point do we ask Federal, State, and local governments to work together with private entities? You mentioned in your testimony that 90 percent of them turn out not to be clusters. Well, what do you mean by that? If you don't know what a cluster is, how do you know that it's not a cluster? That seems to be a fundamental question we need to have answered. I would appreciate us giving some thought, as we go forward, to this, and maybe the Pew Center will give this a great deal of thought as well.

Senator REID. Senator Clinton.

Senator CLINTON. I'm clustered. I thought I was making progress understanding all this, but now I feel like I've gone 10 steps back. I think that may be helpful, because, clearly, we have a lot more questions than we do answers, and I think it's very important for us to begin to put into place the capacity to define the questions clearly and then to begin to answer them. From what I understand with this panel, that seems to be their recommendations.

Dr. Hearne, I really appreciate the work that the Pew Foundation has done with the report and now following up with the Trust for America's Health, and I am very pleased that you got specific recommendations, that it's not just an analysis that doesn't tell us

what you think should be done, and they're pretty hard hitting recommendations, I must say. Maybe, Harry, the reason that Dr. Hearne is the front woman is because she seems so much less hard than the recommendations.

Dr. HEARNE. They're willing to sacrifice their young.

Senator CLINTON. That's right, sacrifice their young for this.

One thing that you said which really caught my attention is that the proposed budget from the administration recommends severe cuts for the Nation's chronic disease prevention programs. Can you elaborate on which programs are slated to receive cuts and how those cuts might impact on what we're talking about today, which is to put into effect a health tracking system nationwide that will assist people at all levels of government?

Dr. HEARNE. As you know, the budget from the administration was just recently released. So we're still going through those numbers, but currently the Center for Chronic Disease and Prevention at CDC has been targeted with a 23-percent cut of its budget. That is the sentinel spot in this country for work on looking at the prevention opportunities of reducing the No. 1 cause of death in this country. I highlight that because I think there has been a very strong bipartisan commitment in this country to really move forward and advance our biomedical research, and I cannot applaud that effort more as a health scientist.

But I think it's also important—I think Dr. Prescott actually noted this earlier on the first panel. We're at a stage right now that we need to be starting to apply our knowledge into the clinics, into the communities on how to actually respond and prevent disease. We can't simply be investing on the treatment side. We must stay with that front, but we have the opportunity within our grasp for preventing disease. I think one of the great examples—Dr. Sinks mentioned folic acid and how our knowledge of that very simple vitamin or nutritional addition to our diet has been reducing the cause of neural tube defects, a key birth defect in this country that was actually discovered from a birth defect registry in Texas. Texas had a terrible birth defects crisis many years back and couldn't answer the community's concerns, because they didn't have a tracking system. Texas now has one of the best tracking systems in the country for birth defects, and it was able to put that information together, that by adding folic acid to the diet, we can prevent birth defects. That's where this entire concept of nationwide health tracking comes from, that we need to have those investments.

Is there a line item for a nationwide health tracking network? No. We hope, though, through leadership—and that was, yes, the Pew Commission's recommendations. We made it as simple but hard hitting as possible, and thanks to Governor Weicker, Lou Stokes, and other thoughtful Members of Congress, they're meant to be pragmatic, to deal with the concerns that communities have, with the thoughts that the clinicians have, the agencies. We heard from the State's own epidemiologist and health officers—we need to track.

Senator CLINTON. I hope that out of this hearing, which you know certainly is receiving a lot of national attention, not just attention here in Nevada, that we'll take another look at that, be-

cause there has been a very strong push to increase and double the NIH budget, but if we don't start applying what we have learned to prevention, then we're going to be constantly playing catch-up, and I don't think that's in our best interest.

I also believe it's important, as you point out in your report, that there are other diseases or conditions that seem to be increasing without any real understanding, and you said autism. I recently met with a group of experts on autism, and it is just astonishing how much autism we now find among our children. In fact, it seems to be down to about 1 out of 200 to 250 children who are being diagnosed with some form of the autistic syndrome. We know we have an asthma epidemic in many parts of our country. It's the leading cause of admission into hospitals, and we haven't yet figured out what it is we're doing in our homes and in our communities that is prompting so much asthma.

So I really do hope that the recommendation that Dr. Hearne is putting forth is going to be given some serious thought in Washington and in the administration, as well as in Congress, so that we can start to find out more about a lot.

I just had one question, perhaps, to Dr. Falk. Under the toxic chemicals, the list and the myriad numbers of chemicals that are out there that have an impact on our well-being and our health, what predictability are we putting into some of our effort with regard to these diseases that we're now seeing? Where are we with regard to that level of predictability? Do we have a high confidence in that predictability, or is it at an evolving predictability level?

Dr. FALK. I think this is very much evolving. We know that there are relationships between certain toxic substances and disease, lead and lead poisoning and so on, but the great bulk of diseases, in terms of chronic diseases, is really of unknown etiology. We don't understand what causes most chronic diseases. There are some—cigarette smoking, for example, and lung cancer—where we have a pretty good understanding, but many types of cancer, other types of disease, we don't understand really all of the factors that cause those diseases.

I think one of the important aspects of doing better health tracking would be to identify in a better way what are the likely environmental inputs to disease, what are the environmental factors that may relate to disease. I also think that we could do a better job of coordinating the collection of environmental data and the collection of health data. We have a lot of environmental data bases. The EPA, State health departments, and others have health data bases, but we probably don't do a sufficient job of actually linking those data bases to look for the connections that might help fill in some of the blanks. So what Shelley Hearne and the Pew Commission have espoused is a better collection of health data, but I think part of that also is better linkage to environmental data to explore the potential concerns.

Mr. GIBBONS. Ms. Trovato, thank you for being here. It's not often that we get the EPA with such a powerful individual. I would like to put you on the spot. We do know that the EPA does have a provision for their safe drinking water infrastructure funding. Could we get a commitment from you for this community here?

Ms. TROVATO. We distribute that money to the States, and then the States make the decisions, so we would have to begin with a converstion with the State of Nevada.

Thank you, Mr. Chairman.

Senator REID. Thank you, Congressman.

Dr. Falk, I want to thank you and your agency for conducting the medical screening of approximately 70 people in Elko who had worked in Montana and been exposed to asbestos-related illnesses. That brought a sense of relief to those people, some of whom got bad news, but the vast majority of them got good news. So we're going to follow that, but I think it's important to recognize that the work that has been done there is extremely important and will have a long and lasting impact on, I guess, a positive feeling of the people who have been pulled out of the blue, so to speak, and told that they need to have these tests conducted, and it was one example that the Federal Government's here to help.

Dr. FALK. Thank you.

Senator REID. I understand that Nevada's cancer registry is currently not certified. What does this mean, Dr. Hearne?

Dr. HEARNE. There is a national program with a long title, NAACCR. I think epidemiology might be in there somewhere, so I don't want to tackle that one. But it essentially sets a series of criteria of expectations with minimal performance for a cancer registry, to ensure its timeliness, its accuracy of information, and the quality of analysis that is conducted with that registry. In the last few years, that organization has been announcing which States, which programs actually meet the national standards of quality. It had been a very small number back in 1995. It's been increasingly going up, partly a reflection of the Federal commitment to invest in cancer registries.

Nevada is probably one of the last States right now that has failed to meet those national standards. In part, I believe recognition—and I don't know the details on Nevada's system, but I think it reflects that it has a limited ability to collect all of the cancer cases in the State, because information is limited by being generated from the hospitals. Today, with increasing outpatient care, there may be many cases that actually slip the radar screen, so that there would be significant under-reporting in this State. In addition, lack of resources prevent a timely analysis and dissemination of that information, information that is critical to the communities, to health workers, and many others involved in doing investigative research.

Senator REID. How does anyone on the panel recommend that Federal and State agencies go about correlating exposure to toxins in the environment? It seems to me that we have a lot of things in the environment that we know aren't good for us, but we don't have any way of correlating where they are and what they do.

Dr. SINKS. I'm going to try to answer that by saying, I think we've got a tremendous amount of work before us to truly coordinate all of these data bases into something comprehensive that can be used, and not only comprehensive but useful, in terms of the type of information that exists.

From our side at the Centers for Disease Control and Prevention, we're only beginning to launch into a new era where we're col-

lecting national data on levels of contaminants in people, body burdens, if you will, of pesticides, of heavy metals, of chemical contaminants that exist in people. We believe that's one of the best ways to determine what's actually getting into people. But we need to link that information as well to the type of data that the States collect on drinking water, air pollution releases, those things, and we need to make those connections.

Senator REID. My concern is that there was a period of time when the State of Nevada was required to collect information dealing with people who gamble. We did certain things and collected all the information, which the Federal Government just dumped in a warehouse, and no one ever looked at it. It was just collected. For what reason, I've never learned. In this instance, we not only don't collect information, but when we do, it's not correlated.

Let me close by saying this: I know for the parents of these children who are sick, we need some finality. I have heard, during the time that we've heard these three panels—I think there's an agreement that we could all have that would give some consolation to these families. First of all, I think there is a consensus among the panelists on the recommendations of Dr. Hearne for a national system for tracking environmental exposure and chronic diseases. All four of you agree there, do you not?

Do we also have a consensus among this panel on the recommendation of Dr. Hearne on the need for a coordinated rapid response protocol within the Federal Government, who will work in conjunction with State and local health officials to address these clusters or other environmentally-related illnesses. You would agree with that also. Is that fair?

[Nod in agreement.]

Last, do we have a consensus among the panelists on the recommendation of Dr. Guinan for a Federal blueprint for State investigation of clusters and for environmental monitoring, in conjunction with the Federal Government?

[Nod in agreement.]

So I think those are three things that are very important.

Yes?

Dr. SINKS. Senator, just as a last particular point, I want to emphasize as well the partnership of the States. Most of the States do have protocols for dealing with these issues, and I think that whatever we at the national level do, we need to partner with the States and involve them in these discussions and make sure that we are doing this together with the States.

Senator REID. I think we've learned, in all things—I had a hearing earlier this week dealing with the environment, and it was clearly established by everybody that no matter how well-meaning the Federal Government might be, unless the people on the ground, locally, are involved in what we're trying to do, it won't work. So the same applies here.

Senator Ensign.

Senator ENSIGN. Thank you, Senator Reid.

I think it's really been an excellent hearing, as far as the information coming forward. It's really been terrific.

I want to address the three questions, because I want to try to have an understanding of how to go forward. Senator Reid, I'm

glad you asked those questions, because that's exactly where I wanted to go with my last line of questioning. Dr. Guinan had said earlier, and you and Dr. Hearne have talked about matters that seem to have somewhat to do with each other. How do you structure this, and does money come from someplace else? Does a new bureaucracy need to be set up, and which agency or which entity is it to be set up in?

Dr. HEARNE. This isn't rocket science. This is what public health did with infectious disease back in the 1800's, and we've won those battles. What we need to do is have CDC in partnership with ATSDR and the State and local health departments, modernize the public health system to deal with chronic diseases. This effort must build on the existing systems. They're antiquated systems and they've been starved for a long time. It would take both an infusion of money—and I'll answer that second part of your question—but it really is about building on what we already have there, with a focus on chronic disease and environmental exposures. It really just takes the vision, as you've heard, from all of today's panelists. We just now have to have the leadership to make it happen.

We're not talking about a lot of money. I think the first installment is getting a chronic disease investigator into every State. There is already a system of EIS officers that could be augmented to get that to happen. The tracking systems will take an investment, but we're talking about a fraction of money in comparison to many of our other investments on both the health and environment side. I ideally would love to see the health investments in this country increase, but I know that that's more of a challenge, and I'll throw it back to Congress in terms of where the money comes. But $275 million—it's about 200 miles of highway roads—a fraction of one environmental investigation into ambient air monitoring programs, is what many people call "dust" in the budget process. With a little creative thinking, that kind of small investment could go a long way and really could modernize our public health system.

Senator ENSIGN. Dr. Falk, you wanted to comment?

Dr. FALK. I certainly agree. You know, at ATSDR—the original CERCLA legislation gave us the name of Agency for Toxic Substances and Disease Registry—though I think that for too long our agency never really actualized the last part of the name, "Disease Registry." So I see that as a direct responsibility under our mandate, and certainly not one just for us, but one that we would work on with the CDC and others. So I think, for ATSDR, we would be very interested, willing, and certainly eager to participate in thinking through these issues and developing a better system.

Senator ENSIGN. I'm glad you said that.

Two other comments. One is that, in veterinarian medicine, we actually focus on prevention. That's what our whole focus is—diet, vaccinations, population, medicine. I've often said and campaigned on many times that America has a sick care system, not a health care system, and we need to change it more to a preventive health care system. So I'm glad that—and the families, I hope, take some comfort in—really, some good may come out of this hearing today. Some profound changes in our health-care system could come from this hearing today. I think that that's very exciting. But I can't get away without letting Dr. Falk answer a question that I asked of

the last panel. Regarding the issue of the Superfund site up on the Carson River, are there funds available that we can possibly get to use for this situation down here?

Dr. FALK. You know, our role is to advise EPA. We don't disburse the clean-up funds, but, in our role of advising EPA, we will take that question up with them and discuss it.

Senator ENSIGN. I appreciate that.

Dr. SINKS. Let me respond a little bit to the last question, not in terms of the Superfund site, but in terms of what we're doing with Fallon and the State. Everything recommended by the expert panel, that is being asked of CDC and ATSDR, we will find the resources in our budget to see that it's done. We are not going to ask the State of Nevada to provide us resources to help them in that work. I'm not sure what additional resources we particularly need, we'll have to wait to see the exact protocols. Every time I have asked for help from EPA or ATSDR, it has been forthcoming. We will get those resources and we will see that they're delivered to this issue.

Senator REID. Senator Clinton.

Senator CLINTON. Yes.

Dr. Falk, would you mind submitting for the record what ATSDR activities and ongoing studies are currently underway in New York, just so that I have that information?

Dr. FALK. Sure.

Senator CLINTON. I sure appreciate that.

Maybe we've got the makings of a Reid-Ensign-Clinton public health bill that will be, of course, sponsored by Congressman Gibbons in the house. I think that, like John, I am really pleased at how much information came out, certainly information I was not aware of, and some of the interactions among the agencies that we can zero in on and try to create more support for, as we do upgrade our public health system. One of the real issues, I think, for the 21st century for our entire country is how we build on the successes of the past, because I'm certainly sure that every one of us want to live and continue to live in a country where the water is safe to drink and the air is safe to breathe and the food is safe to eat, and, yet, I think we've fallen behind in dealing with some of the challenges that we've now heard very eloquently addressed and that we have an obligation to try to come up with solutions for.

I appreciate the consensus among this panel and the previous panelists about what needs to be done. I would just point to, perhaps, some analogous situations. You know, we now have a very good Federal emergency management assistance program. We worked on it over the years, and it had to be improved. We now not only deal with emergencies when they occur, we've put in a lot more on the preventative side, and I hope we continue to do that. You know, we help people deal with earthquake issues after some terrible earthquakes, and we really cut the amount of loss of life and damage from the Seattle earthquakes. We have dealt with hurricanes and tornadoes and other kinds of natural disasters. Certainly we have had a good response to outbreaks of food poisonings, like E. coli and the like, and I think we need to look at that system. So I believe that we've got some good public, private, and State, Federal, and local partnerships to look at as we address the

concerns that have been raised at this hearing, and I anticipate there'll be a lot of work done in order to be able to come up with some solutions.

So I really want to thank all of the panelists for coming forward.

I join with the Senators up here in our compliments for the panel and the testimony that they've presented to us today was very enlightening. I do believe, as many of you do, that if we are going to ever reach parity between treatment and prevention, that we are going to have to make some significant investments into this system. It is enlightening to hear the testimony, but I also am reminded that over the last 20 years, the evolution of information technology has made a contribution to the macro side, which is where I believe each of you is suggesting that we go—to look at the broad picture, as well as the narrow choices that we have in making some predictability to these diseases that we have affecting us today.

I just want to thank you again for your presence here today.

Senator REID. I want to thank everyone for being here today. The audience has been considerate and polite and quiet, for which we all up here acknowledge and extend our appreciation.

We have here about 20 questions that have been submitted to us. As you can see by the time, we're not going to be able to answer those orally here today, but, as I indicated, everyone here has their name and address, and we will in detail answer these questions.

I want to extend my appreciation to the Environment and Public Works staff. They have been working on this hearing for several weeks. We've had people here on the ground. These are your taxpayer dollars being spent to prepare this hearing. You should be very proud of the work that each of these individuals have done to allow us to arrive at this point. I want to extend my appreciation to the staffs of Senator Ensign, Senator Clinton, and Congressman Gibbons for also working to make this hearing as good as it has been.

Let me say to the reason that we're here, the parents and the children who are afflicted with this disease: This program which has been conducted today has been helpful, and we are going to do everything we can to find out if there is some cause that we can find that has resulted in the illness of your children, but also everyone within the sound of my voice should understand that in the future we're going to do a better job with these clusters. We're going to have the ability of the Federal Government to respond in a way that we haven't responded in the past. As it's been indicated, we're not going to each time reinvent the wheel. Every time, for example, there is an airplane crash in America, we have the National Air Traffic Safety Board who responds immediately. They know exactly what they're going to do when an accident occurs. We also want to be able to respond that quickly and scientifically.

I wish I could express to the panelists how much I appreciate your time and expertise. From the first witness to the last, it has just been a feast of information. Now we turn this over, as we do so many times, to our very responsible staffs and they're going to prepare a report based on the testimony—every word has been taken—and they're going to report to the committee and to the

Congress and, hopefully, come up with things that are going to be beneficial to our country and certainly the community of Fallon.

This committee stands in adjournment.

[Whereupon, at 1:00 p.m., the committee was adjourned, to reconvene at the call of the chair.]

[Additional statements submitted for the record follow:]

STATEMENT OF NEVADA ASSEMBLYMAN MARCIA DE BRAGA

Good morning. It's a great pleasure to welcome you to Fallon and we want to thank you for convening these hearings.

In the fall of 1999 I read with sadness a story in our local newspaper about a fund raiser for a 5-year old who had ALL (Acute Lymphocytic Leukemia). Then there were a few more cases and more sad stories.

I called the State Health Department and asked if they thought that four cases of ALL in 3 months was an unusually high number in a small community like ours. I was told it might just be an isolated cluster, but they would look into it to be sure.

In less than a year eight more cases were discovered. The statistical probability of this number of cases occurring in an area with our population is one in ten quintillion. In other words, there is almost zero possibility that this cluster happened by chance.

In mid-February, the Assembly Natural Resources, Agriculture and Mining Committee, which I chair, held 3 days of legislative hearings. The purpose of the hearings was to bring together the experts, data, research, knowledge, funds and other resources in an effort to expedite the search for any environmental causes or contributing factors.

The hearings also served to attract considerable media attention and with it a great many offers and promises from individuals and agencies as well as from local, State and national officials to work together for a common—and urgent—purpose.

Others testifying will give you statistics and progress reports. What I want to focus on is what I learned through the Legislative hearings and through listening to the people whose lives have been affected by this tragedy.

As a result of the hearings, we prepared a list of possible causes, created from our research and the testimony we received. That entire list is in your packet, along with the names of agencies and individuals our recommendations have been forwarded to. It basically asks those in authority to leave absolutely no stone unturned.

Our recommendations also include providing information to the public and expanding the scope of the investigation to cover:

- A longer period of time;
- Other disease groupings;
- The analyzing of water, soil and air, and
- The testing of the blood, bone, tissue and hair of the children.

I am happy to report that yesterday the Assembly Ways and Means Committee approved $500,000 to be used specifically for those purposes.

In addition, the committee recommends cleaning up the things the community is concerned about now and not waiting for science to catch up or provide positive proof. We unanimously agreed that the cancer registry and other data must be processed in a rapid manner so that information is current and readily available to health and environmental officials and to the general public.

This leukemia cluster may be only a part of the whole picture. An eminent pediatric oncologist has advised us to investigate all marrow diseases and to look for any increases in other forms of cancer among children and adults.

We know that two additional ALL cases were diagnosed in 1992 and, in 1991, a 5-year old died from Myelodysplastic Syndrome, a less common form of leukemia. We know that earlier this year, a youngster was diagnosed with aplastic anemia, another marrow disease. We know there may be additional cases that are connected to Fallon but were not diagnosed here. And, we know there are clusters of other diseases that also are suspicious.

I think it is vitally important that everyone involved be proactive and not rely on old data, that we look beyond the environmental improvements that are already being done to what needs to be done next, and that we approach our problems with the hope and optimism that, through determination and perseverance, we can—if not find a definitive answer—at the very least eliminate possible causes and add to our information base.

Our legislative committee has sponsored a bill that would require public and private entities, certified to do environmental testing, to report to the Nevada Health

Division or NDEP any findings of specific values that exceed the established Maximum Contaminant Levels. Those findings would have to be made public if a significant health risk was posed.

I think it's imperative that we put these protections into law and aggressively pursue our search for causes. That includes working to eliminate known contaminants. In so doing, obviously we improve the general health of our people and we very well may destroy some of the ALL contributors.

Why do I feel so strongly that we have a responsibility to move forward in every way possible?

Because this is about children—children whose lives have been turned upside down by something terrible that's beyond their control. This is about a beautiful, smiling little girl whose hair is gone. This is about a promising young athlete whose energy now only lasts for minutes. This is about a teenager whose HMO won't pay for a bone marrow transplant.

This, as you well know, is about furthering what is known about cancer so that other communities might be spared what's happened here. I applaud your efforts to create a nationwide team to deal with these situations if and when they arise.

Senator Clinton, I read that you said, "There is no such thing as other people's children." You, Senator Reid, and Senator Ensign have clearly demonstrated that belief by coming to Fallon to hold these hearings. We can't thank you enough for your concern and your willingness to help our community and communities like this, everywhere.

Thank you for the opportunity to testify. I would be happy to answer any questions.

REPORT OF THE LEUKEMIA HEARINGS, FALLON LEUKEMIA CLUSTER, FEBRUARY 12–14, 2001, PREPARED BY LINDA, EISSMANN, SENIOR RESEARCH ANALYST, LEGISLATIVE COUNSEL BUREAU

The Nevada State Assembly's Committee on Natural Resources, Agriculture, and Mining, and its Committee on Health and Human Services, held a series of hearings related to a cluster of leukemia cases in Fallon, Nevada, on February 12, 13, and 14, 2001. They were held in the Legislative Building in Carson City. This report provides a brief overview of the cluster, testimony provided throughout the hearings, and the recommendations adopted.

BACKGROUND

Acute Lymphocytic Leukemia

Childhood *Acute Lymphocytic Leukemia* (ALL) is a disease in which underdeveloped lymphocytes (white blood cells) are found in unusually high numbers in a child's blood and bone marrow. Under normal conditions, the bone marrow makes cells known as blasts that mature into several different types of blood cells, including red blood cells that carry oxygen and platelets that help the blood to clot.

However, in ALL the developing lymphocytes become too numerous and fail to mature. They crowd out the normally-occurring red blood cells and platelets in the blood and bone marrow. As a result, the bone marrow of children with ALL is unable to make sufficient red blood cells to carry oxygen, and the child may develop anemia and tire easily. In addition, without sufficient platelets, the child may bleed or bruise easily.

Acute Lymphocytic Leukemia is the most common form of leukemia found in children, and is the most common kind of childhood cancer accounting for 85 percent of childhood acute leukemias. Thanks to progress made over the last 50 years in the diagnosis and treatment of leukemia, there is now an 80 percent survival rate.

Investigation of the Fallon ALL Cluster

A cluster of ALL patients all under the age of 19, has been identified in Fallon, Nevada. The cluster has been defined by the Health Division as "medically confirmed diagnosis of ALL, in an individual age 0 to 19 at the time of diagnosis, having resided in the Fallon area prior to diagnosis." At the time of the hearings in the Nevada State Assembly on February 12, 13, and 14, 2001, the State's Health Division was investigating 11 confirmed cases of ALL in the Fallon cluster. Of these, one was diagnosed in 1997, two in 1999, and eight in 2000. Only a few weeks later, a 12th case was confirmed (2001) and added to the cluster.

The expected rate of ALL cases statewide is calculated to be 2.78 per 100,000 population per year. With a population of only 7,850 people, the expected rate of ALL in Fallon would be 0.22 cases annually. However, in the Fallon cluster, eight cases were diagnosed in a single year (2000), representing a statistically significant event.

As such, the probability of the Fallon cluster being a random occurrence was determined to be highly unlikely.

The epidemiologic study at the heart of the Health Division's investigation involves a detailed questionnaire for each affected family, a review of all laboratory and medical reports, environmental sampling, and consultation with health and disease experts from around the country, in an effort to find a common link between the cases.

TESTIMONY AT THE LEUKEMIA HEARINGS

Testimony at the leukemia hearings was provided by many State and Federal agencies; local governments; experts in pediatric oncology, childhood leukemia, arsenic research, and cluster investigations; a leukemia patient's family; and members of the general public. Attachment A contains the agendas and topics covered for each day of the hearings.

For a complete overview of the testimony presented, please refer to the minutes of the hearings, found in Attachment B of this report.

Although specific causes of ALL are not known, medical experts testified that several environmental and demographic features (as well as predisposing genetic syndromes) have been associated with an increased risk for leukemias in children. Risk factors for the disease *may* include (but are not necessarily limited to) ionizing radiation, nonionizing radiation, chemical and toxic exposures, viral and infectious agents, and parental occupational exposures. Overall, childhood ALL has been classified by scientists as a heterogeneous group of diseases, with varying immunophenotypes. Testimony also revealed that most ALL cases have a genetic link.

Throughout the hearings, the committees heard a great deal of testimony about a variety of suspected causal factors for the leukemia cluster, including a number of potentially hazardous materials and environmental contaminants. The possibility that the leukemia cases are the result of a combination of factors was another common theme throughout the hearings.

Due to the high levels of naturally-occurring arsenic known to exist in the water supply of Fallon, arsenic was suggested as a possible contributor. However, several expert witnesses testified that while arsenic has been associated with some cancers (including lung, bladder, skin, liver, kidney, and prostate cancers), research has not revealed a clear link between arsenic and leukemia.

In addition to water quality concerns, other factors identified as potential contributors to the ALL cluster were agriculture and domestic chemical uses, military activities associated with the Naval Air Station (NAS) in Fallon, and a variety of environmental contaminants.

The following is a summary of the concerns and possible health risks identified during testimony:

Agriculture and Domestic Chemical Uses

- Agricultural and other pesticides and herbicides used throughout the region.
- Possible effects of combined agricultural activities, including chemicals and crop burning.
- Overall inability to monitor uses of appropriate domestic pesticides and herbicides.
- Need to educate the public about reading label directions for domestic chemical applications.

Water Quality Concerns

- Implications of high levels of arsenic in the Churchill County area water supply.
- Insufficient water quality testing.
- Inadequate laws to require water well testing.
- Need to educate the public about the necessity of water quality testing and possible mitigation activities.

Possible Implications of Military Activities

- Potential contamination/use of hazardous substances at the NAS Fallon, including jet fuel "dumping" or other emissions.
- Stability of the jet fuel line to NAS Fallon.
- Distribution and migration of chaff during military training exercises.
- Microwaves from radar systems.
- Electromagnetic ground waves as a result of the Extremely Low Frequency radio transmitting station installed in Churchill County by the Navy.

Other Environmental Contamination

• Surface, subsurface, and airborne radiation and other contaminants as a result of Project Shoal weapon test conducted 28 miles southeast of Fallon in 1963.
• Adequacy of industrial emissions monitoring (including air, ground, and water contamination).
• Possible implications of ionizing radiation, depleted uranium, radon, nitrates, fluoride, MTBE, volatile organic compounds, other industrial contaminants, and the possibility of other radio nuclides in the Carson and Truckee Rivers.
• Reported PCB contamination at the Fallon Freight Yard.
• Flooding of the Carson and Truckee Rivers in 1997.

In addition to these potential risks to public health, suggestions were also made to improve or expand the Health Division's investigation of the Fallon leukemia cluster:

Cluster Investigation Issues

• Expand the scope of the investigation to determine if there are other leukemia cases or clusters that should be included in the analysis, or any other related marrow diseases that have a bearing on the investigation.
• Determine if there has been an increase in adult cancers over the last decade.
• Consider any combinations of possible factors and the potential involvement of past contaminations.
• Test blood, bone, hair, and tissue samples from afflicted children.
• Occurrence of other possible disease clusters in the Fallon area.
• Possible implications of medical procedures including x-rays, ultrasound, and immunizations.
• Potential role of viral and bacterial infections as a contributing factor.
• Coordination with and guidance to local veterinarians for possible/related animal diseases.

RECOMMENDATIONS

Following the hearings, and upon announcement of the 12th confirmed case of childhood ALL, Assemblyman Marcia de Braga (Chairman of the Committee on Natural Resources, Agriculture, and Mining) requested an emergency appropriation to assist the investigation. Assembly Bill 359 would make $1 million available to the Health Division for expenses relating to:

1. The testing of victims of leukemia;
2. The testing of the environment to determine what factors may be contributing to this outbreak of leukemia;
3. The compilation of data from the results of such tests; and
4. The dissemination of factual information and health advice to the residents of Fallon.

A copy of A.B. 359 is found in Attachment C.

A subcommittee was also formed to evaluate and finalize a list of specific recommendations to enhance the sharing of resources among all participants, and to assist the investigation in finding and addressing the cause of this leukemia cluster as quickly and thoroughly as possible.

Members of the subcommittee were:

Assemblyman Marcia de Braga, Chairman, Committee on Natural Resources, Agriculture, and Mining (NRAM)
Assemblywoman Ellen M. Koivisto, Chairman, Committee on Health and Human Services (HHS)
Assemblywoman Sharron E. Angle (HHS)
Assemblyman John C. Carpenter (NRAM)
Assemblywoman Sheila Leslie (HHS)
Assemblyman Harry Mortenson (NRAM)
Assemblyman P.M. "Roy" Neighbors (NRAM)

The subcommittee met twice, on March 6 and 8, 2001, and adopted a formal list of recommendations. Immediately following adoption of this list, the recommended Bill Draft Request (BDR) was made (and has subsequently been introduced as Assembly Bill 630), and all recommended letters were sent to the appropriate recipients.

Recommendations to Assist/Address the Leukemia Investigation

1. Committee BDR (40–1456, A.B. 630) should specifically include the following:

a. If a public health risk is detected in an area, the overall results should be made public; and

b. Require private or public entities certified to conduct environmental testing (including air, ground, and water testing) to report the results of these tests to the Health Division when specific values exceed the established Maximum Contaminant Levels. The intent is to make sure that the Health Division is able to track or detect any public health risks by having information about contamination or elevated risk levels reported to them.

2. Letter to the NAS Fallon urging it to:

a. Fully disclose to Nevada's Health Division all toxic and hazardous materials historically or currently kept onsite, and all instances of contamination with resulting clean-up measures;

b. Consider any and all other possible contaminates (including those that may have been previously used) as possible contributors, beyond those currently included in the investigation;

c. Evaluate medical histories of families formerly assigned to NAS Fallon, insofar as there may be additional leukemia and other cancer cases in families who have since been reassigned;

d. Compare results of the Navy's water testing of the wells on the base, with the City's test results and any results of testing from the Fallon Paiute-Shoshone Tribe;

e. Address/confirm reports that benzene was found in one of the Navy's wells, and if true, explain when and what corrective actions were taken;

f. Address/confirm reports of jet fuel used in diesel trucks and as weed spray;

g. Explain why Halon 1211 is listed on the NAS Fallon Section 311 "Emergency Planning and Community Right to Know Act" for the 1999 Reporting Year, including how it has been used, is stored, and what "maintenance activities" involved the use of jet fuel; and

h. Consider any possibility that the general public might have come into contact with any of the materials listed on the Section 311 report of reportable materials.

3. Letter to Nevada's Health Division recommending it:

a. Expand the scope of the investigation to determine if there are other leukemia cases or clusters that should be included in the analysis, or any other related marrow diseases that have a bearing on the investigation;

b. Determine if there has been an increase in adult cancers over the last decade;

c. Consider any combinations of possible factors and the potential involvement of past contaminations;

d. Test blood, bone, hair, and tissue samples from affected children;

e. Continue to provide information to the general public and coordinate education efforts about possible public health risks;

f. Continue to solicit input from the public regarding possible causes; and

g. Address/consider the concerns and possible health risks identified during testimony (as previously described on pages 3 and 4 of this report).

4. Letter to the Health Division encouraging it to act as the lead agency to coordinate all educational, research, and investigative efforts.

5. Letter to the Health Division requesting it to proceed with the proposal provided by the University of Nevada, Reno, Department of Civil Engineering, to perform the Ames test on air, water, and "residue" samples collected in the study area, and to work closely with all parties in research sampling efforts with the primary goal being to delineate any areas or sources of increased mutagenic activity.

6. Letter to the Health Division requesting it to thoroughly examine Nevada's Cancer Registry and the current abstraction process, to determine ways in which it could be improved and ways in which the lag time might be minimized. Letter will request the Health Division to undertake necessary steps to improve the registry and report to the Legislature no later than May 1, 2001, what it has learned.

7. Request the Health Division to provide regular updates to the committee(s) about new developments and the progress of its investigation and research, including any reports of its expert panel.

8. Letter to Nevada's Division of Environmental Protection; urging it to:

a. Continue its participation with the Health Division in its oversight capacity for environmental contamination (including air, ground, and water contamination) in the Fallon area; and

b. Continue to monitor the progress of Project Shoal and the migration of surface, subsurface, and airborne contaminates from the initial project site.

9. Letter to Nevada's Department of Agriculture urging it to assist the Health Division in the leukemia investigation, by providing agricultural chemical use data and by collecting and analyzing additional/necessary environmental samples (including air, ground, and water samples) in an effort to help identify any problems resulting from the use or combined uses of pesticides and herbicides in the Fallon area.

10. Letter to Kinder-Morgan requesting information about the jet fuel pipeline, including:

a. The frequency of inspection;
b. Reporting/inspection procedures;
c. Methods used to detect leakage;
d. Precautions used to avoid leakage;
e. History of repairs or upgrades; and
f. Potential to relocate the line if problems are detected.

11. Letter to the University of Nevada, Reno, asking it to assist with the investigation, collaborate with the Health Division, and participate with in-kind contributions to the extent possible.

12. Letters to the City of Fallon and Churchill County, indicating the Legislature has undertaken hearings and held sequent meetings in an effort to combine resources and expedite a solution to the leukemia investigation. A copy of the recommendations will be enclosed. The letters will further indicate that the committees wish to assist the City and County in any way possible in their coordination activities and educational efforts.

Recommendations to Assist/Address the Potential Public Health Risk of Arsenic

13. Letter to City of Fallon urging it to:

a. Take whatever steps are necessary to adhere to the new EPA standards for arsenic as soon as possible;
b. Evaluate opportunities for combining efforts of the City, NAS Fallon, and the Fallon Paiute-Shoshone Tribe to reduce the overall cost of a common filtration system; and
c. Compare its water testing results with those of NAS Fallon and the Fallon Paiute-Shoshone Tribe.

14. Letter of support for Senate Concurrent Resolution No. 5 to the Senate Committee on Legislative Affairs and Operations.

15. Investigate the cost of installing "point of entry" filtration systems at each of Fallon's eight schools.

(Note: Subsequent to adoption of this recommendation, staff learned that the Churchill County School District has determined that "point of use" systems are more cost effective, including 79 reverse osmosis systems at water fountains and kitchen faucets throughout the district. These systems are estimated to cost $70,000 to $80,000.)

Other Recommendations

16. Investigate whether community/public notification is made when the Weed-Mosquito Abatement District undertakes its spraying activities.

(Note: Subsequent to adoption of this recommendation, staff learned that the Churchill County Weed-Mosquito Abatement District publishes an article once per month in the local newspaper, informing residents about mosquito and weed problems, general areas targeted, and chemicals that will be used. However, representatives of the Abatement District indicate that it is difficult to notify the public of the exact time and place to be sprayed because of weather variability. Also, most spraying takes place at the Carson Lake, 10 to 15 miles south of Fallon.)

CONCLUSION

The Committee on Natural Resources, Agriculture, and Mining, and the Committee on Health and Human Services, expresses sincere appreciation to the many witnesses who testified throughout the leukemia hearings for their interest and participation in this unique and compelling situation. Special appreciation is also extended to the Health Division and members of its expert panel for their dedication and the thoroughness of this investigation.

ATTACHMENT A

ASSEMBLY AGENDA FOR THE COMMITTEE ON NATURAL RESOURCES, AGRICULTURE, AND MINING

Day: Monday
Date: February 12, 2001
Time: 1 p.m.
Room: 1214

Briefing.—Health Division.

Medical Overview.—Pediatric leukemia specialists; Local physicians experienced in leukemia and immunology.

Environmental Overview.—Nevada Division of Environmental Protection; Arsenic, Drinking Water Toxicologist, U.S. EPA.

Day: Tuesday
Date: February 13, 2001
Time: 1 p.m.
Room: 1214

Environmental Overview.—Jet fuel, NAS Fallon; Agriculture, pesticides and crop spraying, Nevada Department of Agriculture, Mosquito/Weed Abatement District; Other.

Impacts to the Community.—City of Fallon; Patient families.

Public Testimony.

Day: Wednesday
Date: February 14, 2001
Time: 1 p.m.
Room: 1214

Public testimony.

Medical and Environmental Overview.—Centers for Disease Control; Arsenic research specialist; Oncologist.

Strategies, coordination, and recommendations of the committee.

ATTACHMENT B

MINUTES OF THE MEETING OF THE ASSEMBLY COMMITTEE ON NATURAL RESOURCES, AGRICULTURE, AND MINING, SEVENTY-FIRST SESSION, FEBRUARY 12, 2001

The Committee on Natural Resources, Agriculture, and Mining was called to order at 1 p.m., on Monday, February 12, 2001. Chairman Marcia de Braga presided in room 1214 of the Legislative Building, Carson City, Nevada. *Exhibit A* is the Agenda. *Exhibit B* is the Guest List. All exhibits are available and on file at the Research Library of the Legislative Counsel Bureau.

Committee Members Present.—Mrs. Marcia de Braga, Chairman; Mr. Tom Collins, Vice Chairman; Mr. Douglas Bache; Mr. David Brown; Mr. John Carpenter; Mr. Jerry Claborn; Mr. David Humke; Mr. John J. Lee; Mr. John Marvel; Mr. Harry Mortenson; Mr. Roy Neighbors.

Committee Members Absent.—Ms. Genie Ohrenschall (Excused)

Guest Legislators Present.—Assemblywoman Sharron Angle, District 29; Assemblywoman Merle Berman, District 2; Assemblywoman Vivian Freeman, District 24; Assemblywoman Dawn Gibbons, District 25; Assemblywoman Ellen Koivisto, District 14; Assemblywoman Sheila Leslie, District 27; Assemblywoman Mark Manendo, District 18; Assemblywoman Kathy McClain District 15; Assemblywoman Bonnie Parnell, District 40; Assemblywoman Debbie Smith, District 30; Assemblywoman Sandy Tiffany, District 21; Assemblyman Wendell Williams, District 6.

Staff Members Present.—Linda Eissmann, Committee Policy Analyst; Marla McDade Williams, Committee Policy Analyst; June Rigsby, Committee Secretary.

Others Present..—Yvonne Sylva, Administrator, Nevada State Health; Division; Dr. Mary Guinan, Nevada State Health Officer, Dr. Randall Todd, State Epidemiologist, Nevada State Health Division; Galen Denio, Manager, Public Health Engineering, Nevada State Health Division; Dr. Ronald Rosen, School of Medicine, University of Nevada, Reno; Dr. Carolyn Hastings, Oncologist, Children's' Hospital of Oakland; Dr. Vera Byers, Clinical Immunologist; Dr. Al Levin, Immunologist; Allan Biaggi, Administrator, Division of Environmental Protection; Paul Liebendorfer, Chief, Bureau of Federal Facilities; Dr. Bruce Macler, Regional Toxicologist, EPA, San Francisco.

Chairman de Braga called the Assembly Natural Resources, Agriculture, and Mining Committee to order. Roll was called and a quorum was judged to be in place. All members were present except for Assemblywoman Ohrenschall who was noted as an excused absence.

Chairman de Braga welcomed as guests the Assembly Committee on Health and Human Services. Roll was called, and all members were present, except for Assemblyman Tiffany who was noted as an excused absence.

Chairman de Braga opened the meeting with a welcome to both committees and an acknowledgement of the research and support that contributed to the leukemia hearings. Chairman de Braga stated the purpose of the 3-day special hearings was to gather information about the recent Acute Lymphocytic Leukemia (ALL) cluster in Fallon and to explore possible environmental causes. The hearings had been designed to provide a forum for the pooling of research, data, experts, community leaders, agencies, government officials, health and environmental experts, and all other resources.

With the discovery of 11 cases of ALL in the Fallon area within a short number of years, it had become imperative to address the expected concerns of the residents as well as be aware of the welfare of the community as a whole. With the extensive media coverage, Chairman de Braga explained that publicity had served a positive purpose by bringing attention and resources to the community.

The format for the 3 days was described as a balance of expert testimony and public input. Following the testimony of witnesses, questions by the two committees were slated. Guests were encouraged to sign in and participate, and no questions would be judged as worthless. At the conclusion of the 3 days, a panel would assemble recommendations based on all of the testimony.

Chairman de Braga emphasized that, even if the specific cause of the cluster was never identified, public concerns would be addressed and environmental improvements made on behalf of the entire community.

Because of the pre-scheduled commitments of the two committees in attendance, Chairman de Braga stated that, if at any time, a quorum failed to be present, the hearings would continue uninterrupted under the status of a subcommittee.

Chairman de Braga introduced the opening expert testimony from the Nevada State Health Division. The committees received two handouts, which were as follows:

• A 6-page report entitled State of Nevada Health Division—Leukemia Cluster Fact Sheet (*Exhibit C*).

• A portfolio of reports which included leukemia fact sheets, a summary of what constituted a cancer cluster, status reports, an overview of Health Division actions, and other pertinent background information compiled by the Nevada Health Division (*Exhibit D*).

Yvonne Sylva, Administrator of the State Health Division, outlined their official action since being notified in July 2000 of the high number of ALL cases in Fallon. Their role as the first line of response was recognized. A complete investigation was initiated, with two employees assigned full time, Dr. Mary Guinan, State Health Officer, and Dr. Randall Todd, State Epidemiologist. By November 2000, it became apparent that additional resources would be required. The calls from the news media dictated the hiring of a full time media coordinator as well as a bilingual research assistant to Dr. Todd.

Ms. Sylva summarized the multitude of State and Federal Government agencies that were engaged for the fact-finding phase of their investigation. These included the Center for Disease Control in Atlanta, the National Institute of Cancer, EPA, Department of Energy, the Nevada Department of Agriculture and Nevada Environmental Protection. In January, an additional employee was assigned to field requests from the public and the news media.

According to Ms. Sylva, the investigation had been designed as a partnership with the community of Fallon and was evidenced by a community presentation made to Fallon residents in January. A separate community forum at the Naval Air Station followed, with attendance estimated at 80 residents. A community meeting in early February provided additional opportunity for more than 250 citizens to ask questions and air their concerns. A community telephone hotline (1–888–608–4623) was established, with a reported 56 inquiries to date. Ms. Sylva welcomed additional recommendations for addressing public concerns.

Scrutiny of the Health Division's investigative work had been openly solicited, with requests made to Federal agencies across the country. This peer review was designed to be an analytical critique of the soundness of their investigative methods as well as their findings to date. Recommendations on improvements to their methodology were invited.

In response to Chairman de Braga's question regarding the nature of hotline questions, Ms. Sylva replied that citizen concern centered on the safety of continuing to live in Fallon, the chances of other children developing leukemia, and the safety of drinking the water.

Assemblywoman Gibbons requested clarification of Fallon population figures, the percentage of ethnic minority citizens, history of residents who had requested testing of their private wells, and data on other cancer cases that were linked to arsenic in well water in the Fallon area. Ms. Sylva deferred to the upcoming testimony of

Dr. Todd and Galen Denio. Chairman de Braga clarified that the population of Fallon was estimated at 8,300 within the city limits and 26,000 within the county.

Dr. Mary Guinan, State Health Officer, resumed testimony for the Nevada State Health Division. In July 2000 a call had been received from Chairman de Braga regarding the alarming number of leukemia cases at the Churchill Community Hospital. Following a review of the Nevada State Cancer Registry, it became readily apparent that the rate of current ALL cases in Fallon did represent a significant increase from what would be expected statistically.

Phase 1 of their investigative work commenced with consultation among experts from various schools of medicine and public health agencies. All agreed that phase 1 had to be a thorough interview with each of the affected families for purposes of determining common exposures. Questionnaires from previously conducted epidemiological studies were reviewed, which resulted in the development of a 32-page questionnaire customized for the Fallon cluster. The time to conduct each family interview was estimated at 2–3 hours. The participation by affected families, voluntary in nature, was 100 percent. Scientific methodology was closely followed in the gathering of the data. Interviews of nine families were completed by November. The results were analyzed and presented to the families in December by Dr. Todd.

In response to a question by Assemblywoman McClain regarding the place of diagnosis of the nine cases, Dr. Guinan clarified that the definitive diagnosis of leukemia was a bone marrow biopsy. This specialized test had to be done at the hospital where the treatment would occur.

Assemblywoman McClain requested clarification about the Health Division's ability to track cases in other parts of the nation. Dr. Guinan reported that the publicity did result in the addition of two cases in individuals who were not residents of Fallon at the time of diagnosis. Word-of-mouth reports from the citizens of Fallon contributed to the identification of the first nine cases.

Assemblywoman Leslie inquired about whether the Health Division investigation included the comparison of physical evidence (e.g., blood test results) that might tie these cases together. Dr. Guinan explained that questions did focus on discovering common experiences with the goal of generating hypotheses that could be tested in the next phase of the investigation. Environmental exposures were a principal focus. Additionally, each family was invited to speculate about any theory they had about cause or commonality with other families.

In response to Assemblywoman Leslie's request for clarification regarding testing of the children and environment, Dr. Guinan explained that no testing had been conducted. Phase one was descriptive in nature, and additional testing would be premature until possible causal agents could be identified. Testing of children (e.g., blood, hair analysis) dictated a judicious approach.

Assemblywoman Angle raised the issue of the number of phases of the investigation, any planned efforts to be proactive in uncovering new cases of leukemia, and a timeline of when the results of the study would be available.

Dr. Guinan explained that the number of phases of the investigation was unknown. There had been hundreds of investigations of clusters, with few resulting in identification of cause. The Woburn cluster, one of the few with an identified cause, took 18 years. The Health Division had planned to proceed step-wise. Assurance of public fears had to be the first matter of importance.

In response to Assemblyman Neighbors, Dr. Guinan clarified that an historic review of the health records had been conducted for purposes of comparing the current cancer rate with historic rates. The rate for Churchill County had been the same as the State average, with no increase evidenced prior to this cluster. An essential piece of information was described by Dr. Guinan as the population figures for children up to the age of 9 years in the Fallon area.

Assemblyman Neighbors requested clarification on whether Fallon's drinking water had been tested for substances besides arsenic. Dr. Guinan reported that tests had included radioactive substances and pesticide tests, with no evidence of significant levels. Jet fuel tests of water had been negative as well. It was further noted that some of the leukemia victims were served by the municipal water system while others were on private wells.

In response to Assemblywoman Gibbons, Dr. Guinan outlined the expected rate of cancer versus actual rates of cancer in Fallon. Dr. Guinan reported that the same rate, 3 per 100,000 cases, would be expected throughout the State of Nevada. Multiple comparisons had been made with cancer registries across the nation, and the conclusion was that we had a definite increase in Fallon.

Dr. Todd, State Epidemiologist, resumed testimony for the Nevada State Health Division. Background information regarding communicable disease and cancer reporting practices for Nevada was presented. Dr. Todd referred the committees to his portfolio of handouts (*Exhibit D*). Nevada Revised Statutes (NRS) 441 was cited as

the guideline for their tracking programs for 60 communicable diseases. NRS 457 contained the regulations for tracking cancer. Since 1979, all invasive cancer had been required to be reported by hospitals, with laboratories and physician offices being added to reporting requirements in the late 1990's. It was noted that outpatient management of cancer had interfered with the completeness of data in the cancer registry. This had been compounded by an almost 2 year reporting lag in updating the data of the cancer registry, a common problem nationwide.

Dr. Todd elaborated on the three principal uses of the registry data, which included research, resource allocation, and program evaluation. The value of the registry data was illustrated by its application in cluster investigation.

The unusual number of ALL cases in a small community like Fallon within a short timeframe grabbed the attention of the Nevada Health Division. Using population figures of Nevada communities, mathematical calculations of expected rates and actual rates were scrutinized. Regardless of how the data was sliced, the probability of the Fallon cluster being a random event was judged to be highly unlikely. For the years 1995 to 1999, Churchill County had expected to see only one case of childhood cancer. Statistical analyses were alarming and indicated high probability of a non-random event.

The expected rate in Nevada for residents up to age 10 was calculated at 2.78 cases of Acute Lymphocytic Leukemia (ALL) for a population of 100,000. Churchill County, with eight actual cases, was judged to be a statistically significant event given the expected 0.22 cases for its population of 7,850.

Dr. Todd elaborated on the epidemiological investigation, specifically the 32-page questionnaire. Residential history was examined starting with 2 years prior to the birth of each victim. Occupational history of both parents, medical history of the index child, prenatal history, environmental exposure data, types of pets, activities, and hobbies, household products, types of appliances in the home, and drinking water sources were all investigated.

A timeline was displayed which captured residency in the Fallon area for all of the affected families. Data was charted on bar graphs and then examined for overlapping of residency and other significant marker events. The preponderance of overlapping points was identified as November 1996 through June 1999. This became the timeframe of interest and prompted research questions about coincidental environmental events in Churchill County.

Scrutiny of water analyses received priority attention, especially synthetic organic compounds (SOC) and volatile organic compounds (VOC). None were detected in the municipal water supply that served approximately half of the victim families. Data for private drinking water wells was not complete. Mercury, arsenic, gross alpha radiation, select components of jet fuel, benzene, and select pesticides and herbicides were tested, and all were at or below the allowable limits.

Occupational history data included specific questions about chemical, fume, and radiation exposures on the job. Although some incidents of exposure were discovered, this was judged not to be a common characteristic across all families. The medical history of each index child was reviewed and revealed no common denominator. Maternal pregnancy questions included many subjects such as alcohol and food consumption, medications consumed, occupational exposures, and breast-feeding habits. Questions related to family history of cancer revealed no pattern.

The most prominent question fielded by Dr. Todd during his investigation had been the possible link between leukemia and arsenic in the drinking water. Research did not reveal a preponderance of evidence that linked arsenic with leukemia. Arsenic had always been present in Fallon, which begged the question of why the recent cluster suddenly emerged. The pathway of exposure, as well as the biological mechanism through which a suspected agent caused leukemia, were described as essential elements of their epidemiological investigation.

Chairman de Braga requested clarification about the State cancer registry, specifically at what point in time the registry would have revealed a cluster of cancer. Dr. Todd explained that it would have taken several years before he would have been confident to draw conclusions about a cluster. The lag time between diagnosis and reporting was reported to be common for most cancer registries across the nation. Chairman de Braga urged the Nevada Health Division to submit recommendations about methods for expediting the cancer reporting process.

Assemblywoman Parnell inquired about substances tested in drinking water, specifically hydrocarbons and chemicals similar to those detected in Woburn. Dr. Todd explained that trichloroethylenes and tetracholorethylenes were among the substances tested.

Assemblywoman Smith requested clarification on lag time, specifically whether it was a lag between the initial reporting of the cancer, the completeness, or both. Dr. Todd explained that lag time was a multifaceted problem, with the first component

of lag described as the delay between diagnosis and compilation of the patient's medical record. The second component of lag was related to the abstraction of the information from the medical records, a problem that was evident whether the abstraction was performed by the hospital or by a representative of the Nevada Health Division. Dr. Todd estimated the abstraction time for each medical record at 40 to 60 minutes. The addition of laboratory reporting was anticipated to be a means to expedite the process. By way of comparison, the Center for Disease Control (CDC) standard was reported to be 90 percent at the 1-year mark.

Assemblywoman Smith resumed questioning with a request for clarification of dates of water testing, specifically the inconsistency in the testing schedule and the reported 2-year gap. Dr. Todd deferred to Galen Denio's upcoming testimony.

In response to Assemblywoman Smith's question about private well testing, Dr. Todd clarified that private well testing had most often occurred when the property changed ownership. The mortgage companies, not the state, were the requestors of the water test and reportedly did not routinely order detection of the more complex chemical substances.

Assemblywoman Smith inquired about the possibility of school commonality. Dr. Todd reported no clustering or connection to any school site.

Assemblywoman Koivisto pursued the issue of the amounts of synthetic organic compounds (SOC) and volatile organic compounds (VOC) detected in the water. Dr. Todd clarified that water analyses revealed zero detection.

In response to Assemblywoman Leslie's question regarding high levels of other diseases in the Fallon area, Dr. Todd explained that his review of the cancer registry data through 1999 revealed only the childhood ALL cases in Fallon.

Assemblywoman Gibbons inquired about the probability that the Fallon cluster could be a statistical anomaly. Dr. Todd replied that it was impossible to State with absolute certainty that it was not a fluke. Despite the fact that most cluster investigations failed to conclusively identify a causal link, public concerns dictated the need to continue the investigation.

Assemblyman Mortenson shared his personal experience with recent water testing and cited a line in his water report which stated that radioactive substances were not included in the analysis. In response to Assemblyman Mortenson's request for clarification, Dr. Todd added that the municipal water data presented were historical in nature and not connected to his current investigation.

Assemblyman Mortenson inquired about possible medical procedures and diagnostic x-ray exposure that the leukemia victims may have experienced. Dr. Todd clarified that those were precisely the types of questions asked of the victims. No pattern of exposure, including prenatal ultrasound testing, was revealed. In response to a question of statistical probability, Dr. Todd stated that the projected statewide probability rate of 0.84 per 100,000 residents had not held up in Churchill County. Assemblyman Mortenson next requested if the improbability of such events had been calculated, to which Dr. Todd replied that it had not been determined.

Assemblywoman Berman cited an upcoming bill dealing with the comprehensive cancer plan in Nevada. She specifically inquired whether her bill should be amended to address the need for expeditious identification and response to cancer clusters. Dr. Todd replied that this would require additional thought and that his written response would follow after consultation with his colleagues.

In response to Assemblyman Bache's question regarding the possible connection with the 1997 flood, Dr. Todd explained that the flood had been one of the most prominent events identified for the time period of interest. Initial investigation had not revealed any evidence of contamination of municipal water supplies. Aquifer contamination would need further study.

Assemblyman Brown inquired about the geographic boundaries of the investigation. Dr. Todd reported that the cases were distributed throughout the city and surrounding area. Chairman de Braga called the committees' attention to their information packets and to a copy of the published map which pinpointed the 11 cases.

Galen Denio, Manager of Public Health Engineering, Bureau of Health Protection Services resumed testimony for the Nevada State Health Division. A handout (*Exhibit E*), which outlined the procedures for protection of public water systems, was distributed. Mr. Denio presented an overview of the principal functions of the Bureau, the focus of which was ensuring compliance with drinking water regulations.

In response to earlier questions regarding water testing, Mr. Denio clarified that the maximum contaminant levels (MCL) had been set by the Environmental Protection Agency (EPA) and adopted by the State of Nevada. The contaminant list was described as extensive. In regard to private well water, Mr. Denio reported that the bureau did not test these drinking water sources. In regard to the non-detects referenced by Dr. Todd, current methodology did not allow for detection.

Chairman de Braga cautioned the committees of the need to maintain open minds on the issues, especially given the extensive media coverage and speculation about arsenic as a possible cause. Chairman de Braga requested clarification about the policy and procedure for alerting the public in cases of high level of contaminants in the drinking water. She cited the recent case of private well contamination at Soda Lake and inquired about the follow-up procedure.

Mr. Denio explained that, because it was not a public water system, the Nevada Health Division had not been advised through formal channels. Chairman de Braga emphasized that, although not a public water supply covered by law, it was nonetheless a health threat to residents in that area. She expressed concerns over the lack of a system to alert the residents of the danger.

Mr. Denio clarified that the Federal mortgage lending agencies had required well water testing when the property changed ownership. The State did not have the responsibility with regard to private wells. Chairman de Braga restated her concern that the quality of the drinking water should be disclosed as part of the real estate transactions. This breakdown in communication could be addressed in the final report of recommendations.

Dr. Ronald Rosen, School of Medicine, University of Nevada, Reno commenced testimony. Two handouts, a pamphlet entitled "Epidemiology of Childhood Leukemia" and a one-page summary of comments (*Exhibit F*), were distributed. Dr. Rosen reviewed the remarkable progress made during the last 50 years in the diagnosis and treatment of leukemia, with an estimated 85 percent survival rate. Children had accounted for only 1 to 2 percent of all cancers, with Acute Lymphocytic Leukemia (ALL) the most common malignancy. The projected ALL rate was described as 3 per 100,000. At the point of diagnosis, ALL peaked at 2 to 5 years of age. Gender and race had been discovered as significant, with a male dominance of ALL and a prevalence in affluent white children.

Dr. Rosen explained the differences between the various forms of leukemia. The childhood ALL had been classified as a heterogeneous group of diseases, with varying immuno-phenotypes. He further emphasized the point that 80 percent of all ALL revealed a genetic link. These actual genetic abnormalities within the cells had the promise of enabling scientists to understand how the genetic and environmental factors linked together.

The trend, as described by Dr. Rosen, was one of increasing rates. Trends also included striking differences in the international statistics of cancer in children. Possible explanations were offered by Dr. Rosen and included access to higher quality medical care, a finer ability to diagnose cancer, and better cancer reporting systems.

Dr. Rosen summarized the risk to develop cancer as a complex interplay of inherited predisposition, exogenous exposure to agents with leukomogenic potential, and chance events. Despite impressive advancements in the treatment of ALL, cause had evaded science and, when discovered, was predicted to be complex. Dr. Rosen elaborated by stating that ALL was a genetic disease, but rarely inherited as a genetic syndrome. Of interest was the leukemia rate for children with genetically-based Down's Syndrome, where the rate was 20 to 30 times greater than the general population.

Dr. Rosen restated that little was known about epidemiology and etiologic patterns in childhood cancers compared to adults. A strong causal relationship had been established with prenatal radiation exposure, albeit connected to a small percentage of ALL cases. Through the decades, documentation from atomic bomb events had been thorough and included occupational exposure of workers and their subsequent deaths from cancer. The data for ionizing radiation, overall, had been conflicting. High dose exposure had been correlated to the high incidence of leukemia among survivors of atomic blasts, while age was strongly correlated to the type of leukemia.

Non-ionizing radiation research had been extensive but inconclusive. Finding a control, non-exposed population would be almost impossible. EMF (electromagnetic fields) research had been largely inconclusive and remained controversial. Research on chemical exposures to herbicides and pesticides had been associated with certain forms of leukemia.

Dr. Rosen described the unique population of interest, specifically young children between the ages of two to five in developed countries. Epidemiological evidence supported the view that childhood ALL occurred in this age group due to a rare abnormal response brought on by unusual timing in combination with individual genetic susceptibility to a common infection.

This indirect evidence had been judged to be very compelling. The etiologic role in this infection was described in the context of population mixing. On the subject of population mixing and herd immunity (e.g., polio virus), Dr. Rosen described an

increased risk of infection after population mixing and movement. Leukemia clusters occurred when herd immunity was deregulated by population mixing.

In summary, Dr. Rosen highlighted that in the unique population with ALL it was a delayed first exposure that had been considered to contribute to pathogenesis of several diseases associated with socio-economic affluence. Decreased breast-feeding practices in affluent populations had been suggested as a factor and would need analysis in the Fallon group. An abnormal immunologic response was emphasized as a probable factor in the development of childhood leukemia.

Dr. Rosen highlighted the distinction between descriptive and analytical statistics that resulted from epidemiological studies of leukemia. Interpretation of data had been challenging, with conflicting results between studies. A lack of prevalence of pediatric malignancies plus confounding circumstances contributed to the chance of bias in studies.

In closing, Dr. Rosen reiterated that the Fallon cases had great significance and could contribute to the eventual link of environmental-genetic interactions to the pathogenesis of the various types and subtypes of childhood leukemia. Prevention would follow as a realistic goal.

Chairman de Braga expressed her appreciation to Dr. Rosen. She inquired as to whether the recommendations to which he alluded were in the handouts. Dr. Rosen clarified that recommendations were not included, however he would be happy to contribute input.

Dr. Carolyn Hastings, Pediatric Hematologist and Oncologist at the Children's Hospital in Oakland, commenced testimony. Dr. Hastings had practiced medicine for more than 10 years in northern Nevada and had firsthand experience with the Fallon cluster. It was noted that, because of the relative rareness of childhood leukemia (i.e., 3,000 cases per year), pediatric oncologists across the Nation networked for purposes of sharing knowledge and experience.

The pooling of knowledge allowed for expansion of research and hypothesis generation. Genetic mutation had been determined to be a significant piece of the puzzle. One mutation that had developed in-utero was thought to be complicated by a second mutation in early childhood, probably due to some environmental exposure (e.g., infection). Establishment of the type and subtype of leukemia was described by Dr. Hastings as essential to scientific comparisons.

Demographics were highlighted as the second essential component of the research. Correlations with age, race, and gender had been established. Children under the age of 5 years and Hispanic children had been cited as having a higher incidence.

Assemblywoman Gibbons requested clarification of the role of socio-economic factors and the possibility of the development of another type of cancer. Dr. Hastings explained that it was impossible to determine with certainty when the leukemia developed in a child.

In response to Assemblyman Carpenter's question regarding the existence of a diagnostic blood test, Dr. Hastings explained that there was no screening test available to predict the disease. The complete blood count (CBC) was described as the most common screening tool. There would be no predictive quality to the test, only diagnostic value. A bone marrow test, described as highly invasive, would alert the physician in advance of active symptoms. Acknowledged as the most conclusive of all laboratory tests, Dr. Hastings added that bone marrow testing would be done only after reasonable suspicion.

Chairman de Braga requested a comparison between suspected environmental causes of lymphoma and leukemia. Dr. Hastings confirmed the similarity. She elaborated on the two major hypotheses, genetics and environmental exposures. Chairman de Braga expressed her gratitude to Dr. Hastings and requested any recommendations.

Following a break, Chairman de Braga called the meeting to order and stated that, because a quorum was not present, the hearings would continue as a subcommittee. An introduction of Dr. Vera Byers and Dr. Al Levin was made. An outline of their presentation (*Exhibit G*) was distributed.

Dr. Vera Byers, a physician with a specialty in clinical immunology, commenced testimony and described with her experiences with the Woburn, Massachusetts cancer cluster case. Woburn was judged to be the prototype for cluster investigation. Dr. Al Levin, a physician and scientist, interjected with his description of the role he played in the Woburn case.

Dr. Levin stated with certainty that he believed the Fallon case would be a very easy case. There had been signature genetic lesions evident in these diseases that could be connected to etiologic agents. Examination of the siblings, parents and neighbors promised to be revealing of any common environmental exposure. Dr.

Levin expressed confidence at discovering the disease process, the causal agent, and perhaps the pathway.

Dr. Byers resumed testimony with an overview of the Woburn cancer cluster. Woburn, a town with a significant industrial presence, saw the development of 12 cases between the years 1969 to 1979. The cause was determined to be well water contamination by tricholoethylene (TCE) and percholoroethylene (PCE).

One of the outstanding features of the Woburn cluster was that the community itself identified the increased number of cases (as did Fallon) as well as the suspected source of contamination. The close proximity of the affected homes was significant. Since 70 percent of all cancers had been known to have a carcinogenic cause (as opposed to genetic), water, soil and air sources were tested for chemicals.

Dr. Byers highlighted the value of testing family members and neighbors to uncover similar abnormalities. In Woburn, immune abnormalities were evident and correlated strongly with TCE contamination. Sources of domestic exposure were scrutinized because it was known that, increasingly, industrial chemicals were invading households in alarming amounts. The significance was described as being directly related to continuous low dose exposures within the contained atmosphere in a home.

Dr. Byers reiterated the need to empower the community of Fallon. Historically, it had been the community (e.g., Woburn) that not only uncovered the cluster but the source of the environmental contamination. The prolonged investigation over almost two decades was attributed to the failure of the scientific and medical communities' to believe the residents of Woburn.

Assemblyman Carpenter requested clarification of the map displaying the location of cases in Woburn. Not all of the dots were included in the Woburn cluster, highlighting the difficulty of cluster identification. In terms of the genetic link, a prenatal exposure compounded by a secondary environmental insult had been the leading theory.

Dr. Levin interjected with an explanation of the role of genetics in the development of all diseases. Disease was described as a function of the individual as he responded to an etiologic agent.

Chairman de Braga asked if the findings in Woburn had been conclusive. Dr. Byers replied that the findings were highly conclusive and included the confirmation of autoimmune abnormalities among family members of the leukemia victims. In response to a question regarding the 20-year timeframe, Dr. Byers clarified that once the active investigation was instigated and publicized, the answers were apparent within 3 years. Woburn demonstrated conclusively that it was in-utero exposure and that when the suspect water wells were closed, new cases ceased within 10 years (i.e., latency period).

Chairman de Braga acknowledged the contribution of Dr. Byers and Dr. Levin and requested submission of their recommendations for future action.

Assemblywoman Gibbons summarized the factors that were known to be correlated with leukemia, for example a virus. She also requested clarification on the socio-economic status of the families in Woburn and the role that Dr. Byers and Dr. Levin would play in the Fallon investigation. Had they been invited to participate? Both responded "no" to the question of invitation.

Dr. Byers expanded her explanation of viral etiology by stating that interaction with a chemical carcinogen was required to trigger the cancer. In terms of socioeconomic class, Dr. Levin stated that all of the Woburn families had great similarity as well as stability (i.e., long term residence in the area).

In response to Assemblyman Carpenter's question about the known causes of up to 70 percent of cancers, Dr. Byers stated that triggers such as smoking and tricholorethylene exposure had been well established and documented. Assemblyman Carpenter observed that there appeared to be more cases of cancer, despite the recent medical discoveries. Dr. Byers shared her theory on the movement of industrial chemicals into households and the significant increase in exposure. Dr. Levin added his observation that pancreatic and brain cancers, once rare, had become much more common today. Breast cancer appeared to be epidemic.

Assemblyman Carpenter probed for a theory on the increase in cancers. Dr. Levin explained that brain cancer had been tied conclusively to maternal cigarette smoking and exposure to certain pesticides.

Assemblywoman McClain requested a comparison between Fallon and Woburn, specifically the compact number of years in the Fallon cluster. Dr. Levin stated emphatically that the circumstances in Fallon suggested an ideal case and great opportunity to learn. Chairman de Braga expressed her hope of the continued involvement of Dr. Byers and Dr. Levin.

Testimony resumed with Al Biaggi, Administrator of the Division of Environmental Protection. A report entitled "Environmental Conditions Summary of the

Fallon, Nevada Area" (*Exhibit H*) was distributed to the committees. Mr. Biaggi introduced his staff and then presented an overview of the agency's principal activities.

Water quality issues received highest priority with Nevada Environmental Protection. Issuance of permits, followed by quarterly compliance reports were, reported to be the key elements of their water monitoring programs. Periodic inspections had been conducted by the agency to further ensure compliance with regulations. Mr. Biaggi referred the committees to the handout, which contained summary tables of caseload data.

In terms of Fallon, Mr. Biaggi described the area as not being a heavily industrialized area. Fallon had a total of 64 permits, with 14 connected to industrial storm water and 19 assigned on a temporary basis for cleanup of site contaminations. Waste management covered solid waste (i.e., landfills), waste generation of hazardous waste, and the oversight of facilities using highly hazardous materials. Mr. Biaggi added that there were four facilities in Fallon designated as hazardous waste facilities, one being a chrome-plating operation and the remaining three being geothermal power plant operations. In regard to solid waste management, there had been a steady decrease in the number of landfills, with only one remaining in the Churchill area.

Mr. Biaggi outlined the air quality programs which operated in concert with the permitting processes described above. For Fallon, only two companies at three facilities had been subjected to reporting under the EPA TRI—Toxic Release Regulations. Statistics for the two companies had been unremarkable.

Strong inspection and enforcement programs ensured compliance with regulations. In Fallon, there were permits issued for six geothermal plaints, six mineral processing facilities, eight sand and gravel operations, two industrial permits, four surface area disturbance permits, and two NAS permits (e.g., boilers and power generators).

Data for spills and accidents revealed 86 sites in the Fallon area, with 76 cases involving petroleum products. Ten cases were reported to be still active.

Mr. Biaggi introduced Paul Liebendorfer, Chief of the Bureau of Federal Facilities, who presented an overview of the Fallon Naval Air Station activity. Mr. Liebendorfer stated that 26 sites were known at the base and under current scrutiny. Principal contaminants included fuel oil, paints, solvents, and industrial refuse materials. The upper aquifer had been contaminated to a depth of 20 feet, however no contaminant had migrated off the base. General ground water flow was known to be to the southwest direction and away from the Fallon area.

Chairman de Braga requested clarification on the testing of soil and air in addition to water testing. Mr. Leibendorfer explained that all of the contamination had been determined as subsurface, therefore no air tests were warranted. Chairman de Braga questioned the follow-up procedures for fuel dumping. Mr. Biaggi interjected to explain that fuel dumping in the air was considered a distinct activity and not related to their responsibility to address soil and ground water contamination.

In reply to Chairman de Braga's question about well contamination with JP8 jet fuel, Mr. Biaggi acknowledged a problem with groundwater contamination at the site with JP8.

Assemblywoman Gibbons asked for clarification on the scope of the authority and the ability of the State Environmental Protection Division to govern environmental events at the Fallon NAS. Mr. Biaggi characterized the relationship as a cooperative agreement with the Federal Government.

In response to Assemblyman Carpenter's question regarding detection of jet fuel in well water, Mr. Biaggi stated that there had been no indication of hydrocarbon contamination. Assemblyman Carpenter next asked Mr. Biaggi if other tests had been conducted which might provide insight to cancer. Mr. Biaggi reiterated that municipal wells were tested frequently and that hydrocarbons had not been detected.

Chairman de Braga stated that it would be helpful to get a list of recommendations which included what could go wrong. Mr. Biaggi explained that there had to be an exposure pathway and that the mere presence of a chemical contaminant would not be enough to cause harm. Water would be suspected as a likely pathway, however there had been no proof to date.

In response to a question about agricultural activities by Assemblyman Carpenter, Mr. Biaggi acknowledged the testing of water for agricultural contaminants. He referred the committees to the Nevada Department of Agriculture.

Mr. Biaggi reintroduced Mr. Liebendorfer and the topic of the Shoal Project, an underground nuclear detonation near Fallon in 1963. Through the years, testing and remedial efforts were implemented, and Mr. Liebendorfer described the site as contained today. Ground water wells had been monitored through the years, with

one well revealing traces of a radionucleide. Any movement of ground water would be away from the Fallon area.

In response to Chairman de Braga, Mr. Liebendorfer clarified that the wells had been tested within the last 6 months. The Department of Energy had hired the Desert Research Institute to conduct a full-scale study of the groundwater movement at the site of Project Shoal.

Mr. Biaggi concluded his presentation with mention of Nevada's only superfund site, the Carson River. With known high levels of mercury, the Carson River had long flowed through the Fallon area, however, links between mercury and cancer had not been established.

Assemblywoman Gibbons requested clarification of the flow of groundwater to the east. Mr. Biaggi reiterated that the flow and any potential contaminants from the navy base would be away from the Fallon community. Mr. Biaggi expressed his appreciation for the opportunity to participate and assist in the investigation.

Chairman de Braga introduced Dr. Bruce Macler, Regional Toxicologist, EPA, San Francisco. Dr. Macler shared a handout of his presentation (*Exhibit 1*). Dr. Macler stated that the focus of his testimony was arsenic and its possible relation to the Fallon cluster. Exposure routes to arsenic were described as varied. Dr. Macler emphatically labeled arsenic a poison, regardless of ingestion route. Arsenic had been conclusively linked to lung, bladder, skin, liver, kidney, and prostate cancers, as well as diabetes and neurological complications. Like other cancers, leukemia occurred when damaged genes caused cells to reproduce uncontrollably.

Dr. Macler elaborated on the quantification of disease rates and associated arsenic levels. Extrapolation downward from certainty to uncertainty was voiced as a concern. Some cancer risks had been quantified with confidence; however, information was not abundant on the association with childhood leukemia. International studies (e.g., Bangladesh) did not reveal an increase in childhood leukemia cases. The mechanism of arsenic damage appeared to be related to the repair mechanisms of chromosomes. Acute Lymphocytic Leukemia (ALL) had been linked to genetic damage in earlier testimony. Dr. Macler speculated that arsenic did not initiate the leukemia but rather established a toxic background so that the actual causal agent could trigger the leukemia. Whatever agent triggered the leukemia was amplified by this toxic background, asserted Dr. Macler.

The question persisted in scientific circles about why Fallon had not witnessed increases in other cancers. Over a lifetime, with an estimated 10,000 residents in Fallon, 100 people would be expected to get cancers of all types from exposure to arsenic.

Detoxification of arsenic was described as a methylation process in the human body and was said to offer some protection to the human. Thinking had changed drastically in recent years, and the distinction between safe and unsafe forms of arsenic was obliterated. In moving from the known to the unknown in calculating risk, regulations interfered with risk assessment. Dr. Macler emphasized that toxicology and epidemiology and risk assessment were described as different processes, but interrelated fields. Risk assessment was depicted as a process that had been driven by regulatory needs.

Dr. Macler emphasized that there was no known threshold for arsenic and corresponding adverse effects. It had the status of a nonthreshold carcinogen. In summary, Dr. Macler stated that arsenic posed health risks and regulatory challenges, however the risks could not be used to link arsenic to the childhood leukemia cases. He further stated that arsenic had the potential of being a contributing factor.

Chairman de Braga asked if 10 parts per billion was an unrealistic level or excessively low. Dr. Macler replied that he did not agree, and added that 10 was feasible and a good place to be. Costs were predicted to go down for methods to treat arsenic in drinking water.

Assemblyman Carpenter referred back to an earlier comment made by Dr. Macler and requested that he elaborate on any issues that caused him concern during the day's testimony. Dr. Macler explained that the nature of childhood leukemia and the associated chromosomal damage caused him concern. The immunological steps employed by the body to clean up damaged genes and systems needed more research to fully understand the relationships, especially in relation to arsenic health effects.

Assemblywoman Gibbons asked for clarification about the data that indicated that methlylated arsenic compounds were as toxic as inorganic arsenic. Dr. Macler explained that the source of the data would be found in the Federal register, in the literature, and on their Web site. Dr. Macler reiterated that because arsenic had long been present in Fallon, it was likely to be a background amplifier rather than the primary cause of the ALL.

In response to Assemblywoman Gibbons question regarding the role of individual genetics and impaired immunity, Dr. Macler agreed that there was a possibility of

that association. He did not, however, agree that it could be a fluke. He cautioned the committee members to remember that everyone had been exposed to arsenic in Fallon water, but not everyone got sick. Everyone could have been exposed to something else in Fallon that might have initiated childhood leukemia. Testimony did not indicate compact exposure among these 11 children in Fallon. Variability in susceptibility had to be factored into the investigation.

Assemblywoman Koivisto requested clarification about the calculation of risk, for adults or for children or for both. Dr. Macler stated that the risks were calculated for adults and therefore biased. Risks were seldom quantified for childhood cancer.

Chairman de Braga expressed her appreciation for the testimony. The meeting was adjourned at 5:19 p.m.

Respectfully submitted,

JUNE RIGSBY,
Committee Secretary.

FEBRUARY 13, 2001

The Committee on Natural Resources, Agriculture, and Mining was called to order at 1:18 p.m., on Tuesday, February 13, 2001. Chairman Marcia de Braga presided in room 1214 of the Legislative Building, Carson City, Nevada. As there was no quorum present, Chairwoman de Braga convened the meeting as a sub-committee of Natural Resources, Agriculture and Mining, and Health and Human Services. *Exhibit A* is the Agenda. *Exhibit B* is the Guest List. All exhibits are available and on file at the Research Library of the Legislative Counsel Bureau.

Committee Members Present.—Mrs. Marcia de Braga, Chairman; Mr. Tom Collins, Vice Chairman; Mr. Douglas Bache; Mr. David Brown; Mr. John Carpenter; Mr. Jerry Claborn; Mr. David Humke; Mr. Harry Mortenson; Mr. Roy Neighbors.

Committee Members Absent.—Mr. John J. Lee; Mr. John Marvel; Ms. Genie Ohrenschall.

Guest Legislators Present.—Assemblywoman Sharon Angle, Assembly District 29; Assemblywoman Dawn Gibbons, Assembly District 25; Assemblywoman Ellen Koivisto, Assembly District 14; Assemblywoman Sheila Leslie, Assembly District 27; Assemblywoman Kathy McClain, Assembly District 15; Assemblywoman Bonnie Parnell, Assembly District 40; Assemblywoman Debbie Smith, Assembly District 30.

Staff Members Present.—Linda Eissmann, Committee Policy Analyst; June Rigsby, Committee Secretary.

Others Present.—Captain D.A. "Roy" Rogers, Commanding Officer, Naval Air Station Fallon; Charles Moses, Environmental Scientist, Nevada Department of Agriculture; Mike Wargo, District Manager, Churchill County Mosquito and Weed Abatement District; Ken Tedford, Mayor, City of Fallon; Mike Mackedon, City Attorney, Fallon; Dr. Donald D. Runnells, Senior Technical Adviser, Shepherd Miller, Inc.; H. Robert Meyer, Senior Scientist, Shepherd Miller, Inc.; Bjorn P. Selinder, County Manager, Churchill County; Norman Frey, Commissioner, Churchill County; Gwen Washburn, County Commissioner; Dr. Bonnie Eberhardt Bob, representing the Western Shoshone Nation; Leuren Moret, representing Scientists for Indigenous People; Keith Weaver, a long-term resident of Fallon.

This meeting continued the hearings from February 12, 2001, and was the second part in a three-part series. Chairwoman de Braga requested that committee members and agency representatives write down recommendations to be included in the final report to the Congressional committee hearings to be held at a future date. A work session was planned for February 21 during which no testimony would be taken unless an expert was available, but final recommendations for any legislation would be made.

Captain David Rogers, Commanding Officer of Naval Air Station (NAS), Fallon, Nevada, opened the hearing by reading a statement (*Exhibit C*) that gave an overview of the history and operations of the base since 1942, and issues which pertained to the investigation of the leukemia cluster.

Chairwoman de Braga asked Captain Rogers to explain a little about the pipeline that brought fuel to the base, the route it took, who owned it and who was responsible for monitoring it.

Captain Rogers explained that the pipeline was owned and monitored by Kinder Morgan Co. of Sparks, Nevada; specifically, it was tank 16. A 6-inch pipe ran 70 miles along 1–80, then through Churchill County to the base. NAS assumed responsibility for the fuel when it was on the base. Captain Rogers stated that Kinder Morgan had an extensive monitoring program for leakage in the pipeline, which included pressure differential testing in the pipe and testing of the soils around the

pipe. Kinder Morgan had not found any significant problems. Additionally, air and water sampling done on the base had not indicated any leakage problems.

Assemblywoman McClain asked if any planes came back to Fallon from "Desert Storm" and if there had been any way contaminants could have come back with them. She wondered if the cause of the leukemia problems could be airborne and asked if any investigations had been done to see if that was a possibility.

Captain Rogers replied the airplanes that participated in "Desert Storm" and "Desert Shield" action were not based at Fallon. There was probably a 1½- to 2-year time lag before any of those aircraft came to Fallon for training. The Navy had not investigated the possibility of contamination and submitted that it probably was not warranted.

Assemblywoman Smith inquired if the Navy was doing any follow-up with families that had been in Fallon during this time period to ascertain if they were included in this study.

According to Captain Rogers, the Navy medical community was investigating whether any families which were no longer based at NAS Fallon had cases of acute lymphocytic leukemia (ALL) occur since their departure. This investigation would be completed by the beginning of March. To date, the study was about 60 percent completed and none had been found.

Assemblywoman Smith asked if the fuel-handling procedures included the dumping of jet fuel, or if there had been a particular precautionary measure that was covered in the fuel handling.

In response, Captain Rogers declared, generally fuel handling had many aspects: refueling of aircraft, clean-up of fuel spills which happened either as the airplanes were refueling or if the fuel inadvertently was jettisoned overboard on the ground, and in-the-air fuel dumping above 6000 feet of ground level.

There was an extensive spill containment program; the amount that was spilled was handled in various ways based on the size of the spill. If on concrete, it was cleaned with absorbent materials that were disposed of in accordance with hazardous materials instructions. If the spill was on soil, the soil was excavated and burned. The total number of spills was insignificant in terms of the amount. Captain Rogers offered to provide those figures if they were requested.

Captain Rogers continued, the only reason to jettison fuel over land would be during an emergency when the plane must be reduced to landing weight in order to land. The total number of times this had occurred was perhaps 3 times in the past 15 years. In all three cases, the fuel was jettisoned out to 1he east of the base. As evidenced in the monitoring, the contaminants moved 10 the east out of the base area.

Chairwoman de Braga stated that as she read the articles in the newspaper, she noted a comment that "they regularly see dumping" and asked what might have been seen.

Captain Rogers submitted that probably these were contrails, an action between the exhaust product from the airplane and the water vapor in the air which created a cloud that could appear like fuel. He acknowledged the exhaust from the aircraft smelled like fuel.

Chairwoman de Braga asked if something had changed in recent years regarding the dumping at 6,000 feet rather than the 6,000 meters minimum standard of the Federal Government.

Captain Rogers replied-that the Department of Defense (DOD) regulation is 6,000 feet above ground, unless it was a true emergency.

Chairwoman de Braga, to clarify, stated perhaps it was not a requirement but that above 6,000 meters was estimated to be the proper range above which fuel dissipated or evaporated before it hit the ground.

Captain Rogers agreed but continued that there had been further study. Six thousand feet was the DOD standard until the introduction of JP8 jet fuel. JP8 did not disseminate as well as the JP4 and JP5 that were previously used by the Navy. The Navy and the Air Force were investigating a higher dump altitude. He affirmed that any fuel that did not dissipate in the air would do so on the ground within 18 to 20 hours.

Assemblywoman Gibbons asked, as 1,800 people lived on base and 6,400 personnel resided off the base, were the two military children diagnosed with ALL living on or off the base? And, was there data to compare a base similar to Fallon, and were there any acute lymphocytic leukemia cases on those bases?

Captain Rogers answered the first question by stating he was unaware of where the children lived. Regardless, the water came from the same aquifer. As for the second question, the Navy had done no comparison of ALL rates in Fallon and other military areas. The military medical community was "all over this one" and if there

had been another area with this same rate, that would show up in the investigations.

Assemblywoman Gibbons asked how many of the 8,200 are children. Captain Rogers offered to get the exact number, but estimated it was around a thousand.

Assemblyman Neighbors said that he had seen much of the aluminum foil chaff that was dropped out of the aircraft in the desert and asked if everyone was comfortable that it was not a problem.

Captain Rogers defended that chaff was expended on the range considerably east of the town and any chaff migration would tend to drift further east with the prevailing wind. He explained that a select panel of research scientists from eight universities studied the harmful effects of chaff and concluded that there were none Chaff was a litter issue, not a health issue. The total amount expended at Fallon equated to one quarter of one ounce per acre per year. This was an amount that the Navy was willing to use in the name of combat training. Captain Rogers further affirmed that the combat training done with chaff was essential because it was an end game maneuver that could save a pilot's life if a missile was shot at him. Without that three-dimensional training, people would die in combat.

Assemblywoman Parnell assumed that NAS Fallon had material safety data sheets (MSDS) for toxic wastes and chemicals that they used, and asked if the Health Division had seen them.

Captain Rogers acknowledged the base had that information but was unaware if the Health Division had looked at it.

Ms. Parnell requested to know that the Health Division did have that information in their possession. Ms. Parnell pointed out that in her packet of information she had a 1999 article from the *Las Vegas Sun* regarding the citation of the U.S. Navy by the U.S. EPA for noncompliance and violations of hazardous chemicals that were noted 2 years prior to 1999. She requested to know the current status of compliance.

Captain Rogers claimed the article, as it appeared in the paper, was "not exactly factual." He believed that Mr. Liebendorfer of the State Division of Environmental Protection was aware of the situation and testified on February 12 that the base was in compliance, and what was reported on was a difference of opinion between the State and the base regarding the interpretation of the regulation. That had been resolved.

Assemblywoman Leslie questioned whether the live or spent ordinance on bombing ranges Bravo 20 and Bravo 16 was swept up and discarded, and did this debris have any possible connection to the problem? This range scrap was extensive on the four ranges, Captain Rogers admitted. There were times during the year when it was swept into large piles until portions were removed. Scientists determined that contamination from range scrap piled onsite in these dry alkaline lakebeds was not an issue. Any migration of contaminants would tend to move eastwards.

Ms. Leslie asked if this was checked once or regularly every year. According to Captain Rogers, the DOD Inspector General prepared a report about this and regular testing of the environment was conducted.

Ms. Leslie's second question regarded the reaction of the families of the military. She wished to know if they had asked the Navy for help which had not been touched on in this hearing. The Captain replied this was an emotional issue. The base had held town meetings. He affirmed that the Navy did not feel that Fallon was an unsafe place to live nor that this situation warranted moving families out of the area.

Ms. Leslie asked if the community accepted this or were some asking for transfers out of the area. Captain Rogers believed that the majority accepted this. Just a couple of people asked informally if they could transfer but the Navy would not entertain that until they had been convinced there was a problem. The San Diego-based Navy Environmental Health Command was intimately involved with the investigation and were as concerned as the local civilian community. The Navy was doing everything possible to determine a solution. He continued that if the DOD felt there was an immediate threat, "they would pull out."

Assemblywoman Gibbons questioned whether he knew of any commonality between the two cases with military children and the other nine cases in the civilian community. The only answer Captain Rogers said he could offer was there was nothing that was a common trait. The lifestyles and activities were varied.

Assemblywoman de Braga returned to the pipeline issue asking if the Navy could detect small leakages on the base. Captain Rogers guessed that would depend on the definition of "small" leakages.

Ms. de Braga restated her question to inquire if the pipeline could be leaking in such small amounts that it would not be detected anywhere along its route. Captain Rogers acknowledged that a minute amount of fuel would be detected in any water source. If fuel leaked from the pipeline, he said, the "very aggressive" water testing program would detect it. Ground testing was also done. The results of the testing

were reported to him and to State and Federal agencies that oversaw the base water quality program. He further explained that Kinder Morgan Co. was obligated to inform NAS Fallon if a problem was detected on the pipeline anywhere off base. The base received the results of their testing but Captain Rogers did not "know specifically if there's a requirement for them to do that or not." He would get that information for Chairwoman de Braga.

Ms. de Braga stated that she wanted to be certain that enough precautions were in place. She did not feel that there was "a lot" of ground testing being done, but there was quite a bit of water testing. She questioned again what the Navy was proactively doing differently to help in this effort; e.g., studies, tests, or other possible environmental causes.

Captain Rogers told the committee that the Navy was more sensitive to the environmental issues on base. NAS Fallon, he said, had much pride in the environmental programs he outlined previously (*Exhibit C*). He felt the Navy had a good relationship with the State and Federal agencies which monitored the activities. Captain Rogers revealed that he had a task force on base that assisted with the investigation.

Ms. de Braga asked if the State had the authority to test on base. The DOD and the Navy would give permission if necessary, Captain Rogers replied. Assemblywoman Koivisto asked Captain Rogers about the by-products in contrails that people were breathing. He responded that the exhaust of a jet airplane was similar to that of a motor vehicle. Contrails were essentially water vapor, not a hazardous substance.

Ms. Koivisto stated that since automobile emissions were controlled because of health effects on the population, she found it difficult to believe that a jet airplane did not have as much exhaust as automobiles. Captain Rogers replied that it had a similar composition and offered to get that information for her. He continued that obviously there is a larger amount than a car but State and Federal regulations controlled their air permits.

The next speaker, Charles Moses, an Environmental Scientist of the Nevada Department of Agriculture (NDOA), stated that goals of the Environmental Compliance Section (ECS) were to protect health and the human environment from the adverse effects of pesticides and to assure that pesticides remained available as valuable tools in an integrated approach to pest management.

He stated that pesticides were used and regulated in a number of applications, not just associated with agriculture: in ornamental lawns and turf, golf fairways, household and domestic dwellings, fur- and wool-bearing animals, even pets, wood protection, swimming pools and hot tubs, airport landing fields, tennis courts, highway right-of-way, mosquito abatement districts, and many more.

The challenge of regulating pesticides existed, he said, basically because of the dual nature of the products. That is, they were a tremendous benefit for the production of agricultural products and for the protection of human health, but when they were used inappropriately or inconsistently with label directions, they had adverse affects.

Mr. Moses indicated that the State of Nevada had a cooperative agreement with the U.S. Environmental Protection Agency (EPA), that the State received funding and oversight from the agency to regulate pesticide use, manufacturing, sale, distribution and application.

Mr. Moses continued by giving an overview of the regulatory program that enforced the EPA provisions in the state. This defined a pesticide as any substance that made a claim of preventing, destroying or repelling a pest or a substance or mixture of substances used for plant regulators, defoliants and desiccants.

Since the creation of the EPA in 1972, it has been required that all pesticides must be registered. The law was revised in 1996 to eliminate the benefit factors on food crops and in areas where children would be exposed. All pesticides, new and existing, were required to conform to the standards.

Based on the data submitted for pesticide registration, the EPA developed a label that addressed the hazards of using the products. Mr. Moses emphasized that what set a pesticide label apart from other hazardous chemical labels was that this label was the law. An applicator must use this product in accordance with all information that was printed on the label. A signal word "CAUTION" was used on the label for the safest type product to give an indication of how acutely toxic the pesticide was. In other words, with a large dose over a small period of time, the "CAUTION" gave an indication of whether the victim would experience health effects. For this type of product, he claimed, it would take quite a bit to actually cause health effects. However, the signal word would not say how chronically hazardous this product was, used over an extended period of time.

Lastly, Mr. Moses continued, the EPA gave the State the responsibility of enforcing the pesticide law and the State had to show that it had similar State laws to regulate the sale, manufacturing and use of pesticides (Chapters 555 and 586 of the *Nevada Revised Statutes*). Commercial applicators and farmers were trained, tested and regulated. The NDOA required all applicators submit reports of customers, sites, products and quantities applied. These reports and data have been acquired since 1970.

Mr. Moses said that the NDOA, as part of the agreement with the EPA, did inspections on Federal property and had been to the NAS Fallon airbase to inspect the pest control activities. In most cases, he stated, they found that the Navy contracted with private individuals and licensed companies to do the work. According to Mr. Moses, the Navy asked the contractors "to go above and beyond" what NDOA required, and concluded that they had been cooperative with the Nevada inspectors.

Next, Mr. Moses showed a sample of a sales report which showed who bought restricted-use products. All of this was public information and was available upon request.

Mr. Moses then shifted gears and explained the ground water monitoring program for pesticide residue. In 1988, the EPA found that pesticides existed in low levels in a lot of different areas and in some cases in public drinking supplies and shallow ground water wells. Since then, the EPA has required every State that had a cooperative agreement with them to have a regulatory program designed to protect ground water from becoming more contaminated or becoming contaminated from the applications and use of pesticides.

For a long time, Mr. Moses admitted, it was thought that pesticides could not seep down 150 to 200 feet to water wells. But even with proper application, he said, it had been found that pesticides had properties that may allow them to leach down into ground water. Mr. Moses showed that since the monitoring program was implemented, there had been more detections in urban areas than in rural areas in the ground water sampling.

Mr. Moses distributed a fact sheet (*Exhibit D*) done with the U.S. Geological Survey (USGS) that explained the monitoring program. In most cases, the wells were constructed by the NDOA to look at the shallowest aquifer they could find. If pesticides were to show up in the shallow wells, there would be time to implement regulatory measures before the pesticides leached to the deeper aquifer.

In Churchill County last year, Mr. Moses further explained, water samples from about 20 wells, many of which were put in by the USGS, but some were irrigation wells, were examined for about 40 EPA-registered products. The NDOA did not look for products that the EPA canceled due to health risks because there would be no regulatory measures that NDOA could take to try to keep the pesticide from getting worse because it was no longer being used. No contamination was found in Churchill County.

In one other item, Mr. Moses showed that the USGS did some studies "in that area" of ground water and surface water samples and did find pesticide residues. The chart he used showed the levels were far below what a health advisory would be for these products. Many of the products leached into the ground water were a result of right-of-way applications. These included Atrazine, Prometon and Simazine. He summarized that most of the cases of leached pesticides were not from agricultural products but from use around homes, lawns and right-of-ways. But they were still quite low, far below health advisory levels.

Lastly, Mr. Moses stated that he had information about studies that he had requested the EPA send him. He declared he would be glad to submit them to the committee because there had been some links to different types of uses where the mothers were working with the chemicals when their children developed leukemia.

Chairwoman de Braga agreed she would very much like to see that information because those gaps might lead the committee somewhere in this investigation. She felt it helped them to know the extent to which the NDOA went to protect people from chemicals. But, she questioned, what could go wrong? The bottom line was that there was not complete regulation because you could not know if a housewife mixed 409 and a non-recommended agent which had fine print on the bottle that nobody read. Maybe education would be the key to this. What she and the committee wanted to know is not what was being done but rather what was missed.

Mr. Moses agreed that one problem they had was assessing the use of pesticides by homeowners. There was data in some of the studies that suggested that there were links.

Mrs. de Braga added that even the people who aerial crop-sprayed, who sprayed your house for spiders or whatever, were they taking the proper precautions? And what about accidents? The problems might have been entirely different from house to house.

Assemblyman Neighbors asked about the ground water level of the 20 wells that were tested in the Churchill County. Mr. Moses believed that the monitoring wells averaged about 40 feet. Drinking water and irrigation wells were much deeper.

Mr. Neighbors stated that, as he recalled, Nevada law said you may put a well and a septic tank on one and a quarter acre. Correct? Mr. Moses was uncertain. Mr. Neighbors ask about the percolation rate and Mr. Moses replied that he did not know.

Ms. de Braga suggested that this was not really his area. Mr. Neighbors said it would be interesting to know because there were areas of Nevada where that had become a problem. Too many nitrates might be in the water. Mr. Moses believed that the Health Division had that data and it could easily be obtained from them.

Assemblywoman Gibbons mentioned that the members of the committee were given maps of the Fallon area that showed where the children with leukemia lived. She asked if there was a map that showed the areas where pesticides were used. Could the rainfall or drought years have had an effect on this? Mr. Moses answered that he could probably come up with a map of the agricultural areas but it would be tougher to do the residential usage areas. They did not know what homeowners were using nor how much.

Ms. de Braga inquired about the types of complaints Mr. Moses had received about pesticide use. They ranged from human health and vegetation damage to possible adverse effects to animals, Mr. Moses replied. He got from 10 to 50 of these serious investigations per year. At conclusion, Mr. Moses distributed a list of Available Resources for the Leukemia Task Force (*Exhibit E*).

The next speaker was Michael J. Wargo, District Manager, Churchill County Mosquito and Weed Abatement District (MWAD). He distributed a letter that outlined the activities of the Mosquito and Weed Abatement District (*Exhibit F*). With this he also distributed material safety data sheets for the pesticide used by the District (*Exhibit G*). Mr. Wargo stated that he was a biologist more so than a chemist with a degree in entomology, the study of insects.

Mr. Wargo briefly reviewed the information in the letter that addressed the history of the MWAD, the chemicals they used to control mosquitoes, and the weed activities. To control the mosquitoes, his staff considered the site, the size of the colony, the impact on the area and the population of the natural predators at the site. With the mosquitoes in an early stage of development, natural agents such as a bacteria or mosquito hormones were used for control. In a later stage, a light petroleum oil was used in the water to suffocate the pupae. If mosquitoes reached the flight stage, they were treated with pyrethrum, a compound made from chrysanthemums, or with Dibrom aerially applied over a large acreage. These latter two applications were not preferred because of the expense and the difficulty of application. Mr. Wargo added that most of the mosquito populations were not in Fallon but out in the rural surroundings.

Next Mr. Wargo spoke about the weed control activities that began in 1987. The chemicals used were listed on page 3 of his letter (*Exhibit F*). In 1999 and in 2000, Pendulum was used as a preemergent along the county roadsides. During the summer, Glyfos and Weedone were used. Arsenal was used to create a bare zone that protects a road base from emergent weeds that damaged asphalt. Roundup and 2–4–D were used as needed to eliminate emerging weeds.

Mr. Wargo concluded by saying that, from 1998 to 2000, Tall Whitetop control along the Carson River required the use of Weedar 64 and Rodeo. Some isolated patches of Tall Whitetop, Russian Knapweed and African Rue were sprayed with Tordon.

Chairwoman de Braga asked Mr. Wargo if there had been any substances used that were now considered unsafe.

Mr. Wargo replied that he was unaware of any. All the chemicals they used, he said, were approved and were used extensively throughout the United States by State and county health departments and by other mosquito abatement districts.

Ms. de Braga stated that in the history of the area much was done by aerial spraying, but if it were intended to kill insects, how could it not be harmful to humans who breathed it?

In reply, Mr. Wargo referred to Mr. Moses' previous comments that the EPA required tests to be done before the chemical was registered. The end user had no input into that process.

Right, Ms. de Braga agreed, then mentioned that the committee was back to not knowing what people were breathing in combination with this chemical and what deleterious effect this might cause. She asked if Mr. Wargo was aware of any use of jet fuel, or something with the same components as JP8, for weed killer. She stated she had received a report of this possibility in Churchill County. "No," Mr. Wargo replied.

Ken Tedford, Mayor of the city of Fallon, spoke next. He began his testimony by stating that Fallon was a tight-knit community, taking seriously the good and the bad that happened there. As the investigation into the leukemia cases unfolded, more media attention was paid to the children. He assured the committee that his focus was not on the town's image but rather to put the care and comfort of the children first while preserving their privacy. Mayor Tedford's goal was to establish a single point of contact in the community, a place were the families could go if they had needs that were not met, and a place for those who wanted to give their time, money or talent to assist.

To avoid fear, rumor and lack of information, the city council prepared fact sheets and answers to frequently asked questions (*Exhibit H*) and other information for distribution throughout the community (*Exhibit I*). He thanked Governor Guinn, the State Health Division Administrator Yvonne Sylva, State Health Officer Dr. Mary Guinan and State Epidemiologist Dr. Randall Todd for their efforts. He declared that the city would continue to assist in the ongoing investigation.

Mayor Tedford then began to speak about the city water supply that provided services to approximately 2,900 connections from four city wells pumping water from the Basalt Aquifer. However, he clarified, not all of the affected families were on city water—some used private wells and some drank bottled water. He restated the belief that the city water supply was not the common link in these cases.

He acknowledged that arsenic was present in the water of Lahontan Valley. Many of the 4000 domestic wells, contained naturally occurring arsenic, as did the water in the city and Navy wells. Fallon had known of this arsenic for a long time and had struggled to deal with it. But, there appeared to be no link between arsenic and leukemia, he held.

The city contracted with Shepherd Miller Inc. (SMI), an environmental and engineering consulting firm, to conduct tests and surveys for arsenic removal from the water. The public water system would need to comply with the new Federal standards of 10 parts per billion by the year 2006.

Mike Mackedon, Fallon City Attorney, next read from a brief memorandum (*Exhibit J*) that stated that the city had engaged Shepherd Miller, Inc. in April, 2000, to provide technical consultation. Within the binder (*Exhibit K*) were some of the water reports "in history" that the city had provided to the State as part of its regular reporting duties, under State or Federal law. Additionally, there were numerous studies and analyses conducted by the city in excess of and different from those required under any reporting requirement, and some in direct response to the pattern of leukemia.

SMI had been asked to examine past data to determine the quality of the data to the extent possible. They were further instructed to survey the available or innovative technologies that would remove arsenic from drinking water and select a suitable bent-scale test method, to perform tests, to review and analyze the results, and evaluate the results; to perform pilot-scale testing on the selected treatment technology, evaluate those results, and recommend a final arsenic treatment technology. The bent-scale tests were completed and pilot-scale testing began on November 30, 2000.

Mr. Mackedon continued that SMI's work was expanded in July of 2000 when the city learned of the childhood leukemia cases and that the pattern might have suggested an environmental cause. The mayor instructed Shepherd Miller to: review the available literature and research to confirm or not confirm a connection between arsenic and childhood leukemia, to review the available literature and research to confirm or not confirm a connection between the intake of radon and childhood leukemia, to re-review the historical analysis of the water chemistry of the city of Fallon, to proceed to develop a list of agents known or suspected to cause leukemia, and to perform tests of agents not previously analyzed.

Mr. Mackedon introduced SMI representatives Dr. Don Runnells, Senior Technical Adviser, and Dr. H. Robert Meyers, Senior Scientist.

Don Runnells spoke first, introducing the company, its history and himself, a water geochemist and professor at the University of Colorado. He reiterated that SMI was hired in April of 2000 to characterize the ground water supply and to provide recommendations on water treatment technology to address the arsenic issue. From September of 2000 through late January 2001, SMI reviewed and compiled data from historic groundwater analyses of samples from the city of Fallon water wells to determine if any regulated constituents were present in concentrations above the Nevada drinking water standards maximum contaminant limits (MCL).

With the exception of an elevated value of lead in 1989 and the arsenic in all samples, the water had tested below the primary drinking water standards. In the secondary standards, total dissolved solids in the water had exceeded the secondary

standard of 500 milligrams per liter. It also exceeded the standard for PH that is 6.5 to 8.5, having been around 9.

Based on a very recent literature review for potential leukemia causing chemicals, Shepherd Miller, Inc. developed a list of chemicals and analytes, some of which could potentially cause leukemia, for which there had been no previous testing in Fallon. They excluded from the list pharmaceuticals, analytes for which there were no analytical methods for testing, chemicals used as part of the water treatment system, and highly reactive chemicals that had a very short half-life and were gone quickly when added to water. Those remaining of possible concern included formaldehyde, lead 210, and radium 224. In early February of 2001, the city of Fallon wells were sampled for these additional chemicals. The results had not yet come in.

SMI also looked at the composition of fuels such as JP8 jet fuel, to determine if historic water analyses might contain components that could be related back to hydrocarbon fuels. No historic analyses showed a presence of volatile organic chemicals or synthetic organic compounds above detection limits. These were expected to be found if a fuel supply was, in fact, contaminating the ground water. Dr. Runnells remarked that the Fallon water was "remarkably clean" with the exception of the arsenic. The binder (*Exhibit K*) summarized the findings.

Assemblywoman Koivisto asked for clarification as to why so much emphasis was placed on the water supply when the children who contracted the leukemia did not all use the same water source. Dr. Runnells affirmed that Ms. Koivisto's observation was correct. SMI was brought in originally specifically for the arsenic issue. Subsequently, with the community awareness of the leukemia cluster, the mayor and the city council directed them to expand the scope of their work to include a review of what was known about the relationship between arsenic and leukemia and also to identify other chemicals that might be related to leukemia. Dr. Runnells avowed that SMI did not believe that the city water supply was the problem.

Assemblywoman Parnell stated that it appeared that most experts agreed that the most direct link to childhood leukemia would be that of radiation. She asked if it was possible to look for a radiation link in the water supply or somewhere else.

Dr. Runnells affirmed that SMI was looking at the water specifically for radionuclides. In the binder (*Exhibit K*), Table 4 listed the radionuclides and gave the values they found and the MCL. Gross beta could be composed of a number of radionuclides. Therefore, SMI also analyzed for lead-210 because it contributed to gross beta and had a high risk factor.

Ms. Parnell asked whether anything on Table 4 alarmed Dr. Runnells, especially the gross alpha of Wells 2 and 4. He deferred that answer to Dr. Meyer as that was his field of specialty.

Assemblyman Mortenson asked if the lead-210 was a more energetic beta to which Dr. Runnells replied that it was attracted to the surface of the bone and therefore had a high risk factor. Mr. Mortenson also asked about the short half-life of radium 224 and whether there were products in the decay chain that were stable enough to analyze and then infer back to the quantity of radium 224.

Dr. Runnells replied that radium 224 was a decay product of thorium that normally was not found in the ground in a natural situation. But SMI was analyzing specifically for radium 224 to be certain something with a short half-life was not overlooked. The half-life of radium 224 is about 48 hours.

Mr. Mortenson asked if lead-210 was not a product in the decay chain of radium 224. Dr. Runnells believed that lead-210 came from uranium decay chain not the thorium decay chain.

Assemblyman Claborn requested to know if any studies were conducted on small aquatic animals (frogs, fish, even birds). Dr. Runnells responded that he did not have that knowledge but that perhaps someone from the city or county knew. Mr. Claborn continued that generally when something happened [in the environment] it was noticed lower down in the chain of life. Dr. Runnells agreed stating he made an excellent point.

Robert Meyer, a Senior Scientist (radiation biologist) with Shepherd Miller, Inc. testified next. He summarized the materials in the handout (*Exhibit K*). In late July of 2000, SMI began studies on the potential causes of childhood leukemia. They arranged for Dr. Glyn Caldwell, an epidemiologist, to participate in the health risk reviews.

Mr. Meyer reiterated that SMI reached the conclusion that no obvious link existed between the Fallon water supply and the leukemia cases identified in the area, but the issue was not closed. The literature review summaries were provided in the binder (*Exhibit K*). A clear link between arsenic and leukemia was not revealed in the literature. As it had always been present in the water supply, arsenic did not seem to explain the recent appearance of childhood leukemia. One factor could be other sources of radiation, a known cause of leukemia.

There were a number of possible sources of radiation to which everyone was exposed. Levels of radiation seen in communities were low with respect to the recognized standards for radiation protection. He explained there were different types of radiation that could impact a human. One would be an external source of radiation, such as cosmic radiation, gamma rays and other radiation sources from outer space, and from natural deposits of radioactive materials of the sort analyzed in the Fallon water supply. These natural deposits were also present, typically in low levels, in surface soils and rocks. Exposure from these sources included direct exposure and wind-blown exposure.

Mr. Meyer went on to say that the "Nevada experience is unique, of course, given the presence of the test site and the test that was conducted much closer to the city of Fallon." He had not studied the results of the test nor the weather patterns at the time, but he knew there were cases in which the circulation of radioactive materials was in other directions.

There were also other possible sources of radioactivity in the environment that could have influenced this situation. It was not clear, he acknowledged, how an exposure from the 1950's or 1960's could impact a cancer that was rapidly developing. It would be good idea to examine the possibility of other sources of radiation in the area.

Chairwoman de Braga asked if Mr. Meyers and SMI had compared their studies with those done at the base vis-á-vis the water system. Mr. Meyer replied that they were aware of the findings on the base but had not made comparisons.

Assemblywoman Koivisto asked if the historic levels of arsenic remained the same or were there spikes and, were there studies of the effects of arsenic on children rather than just adults? Dr. Runnells answered that the concentrations of arsenic have been remarkably constant. Mr. Meyer stated that he was not aware of toxicological models that might extrapolate from adult leukemogenesis to childhood leukemogenesis.

Assemblyman Mortenson related to Mr. Meyer that he recalled reading that minor earthquakes could produce fissures. As thorium was all over Nevada, he queried, could a minor tremor release a pulse of radon-224 into the water. Mr. Meyer submitted that radon-222 and radon-220 were produced as a natural decay of uranium and thorium. He had read, too, that one of the ways to identify the potential for an earthquake occurrence would be to measure radon. The release of radon gas then was possible. The total exposure over a period of time would be a major factor in whether or not cancer might result. He speculated that the release of this gas prior to or during an earthquake might be quite brief, yet the damage done to a human body normally accrued over a period of time. A short low-level exposure would be unlikely to increase risk. Risk was proportional to dose.

Mr. Mortenson apologized that he had meant to say radium-224 to which Mr. Meyer stated that he was unaware of particulate materials released during moderate earthquakes.

Mr. Mortenson continued that he had read recently that with volatile organic compounds in drinking water, the "body burden" was via three methods: drinking the water, bathing with it, and through inhalation (steam of showers or cooking). Even though someone might have consumed bottled water, that was a fraction of the way the body absorbed water.

Mayor Tedford of Fallon again testified the city began looking at the water first (*Exhibit L*) because it was something they had control over. The city had also begun looking at their landfills, utilities, airport and other lands that they own. He closed by saying that he hoped the committee would be vigilant in supporting the executive branch that had made this investigation a priority. Funds and staff were important to complete the mission. He thanked the committee for the opportunity to speak.

Assemblywoman Leslie thanked the mayor for his testimony and asked him to briefly describe the plans for the resource center. She hoped that the Fallon Family Resource Center would be included. Mayor Tedford said this was to be a clearinghouse for assistance that would allow the families to maintain some anonymity. The hospital would assist and the Family Resource Center was a good idea.

Bjorn Selinder, Churchill County Manager, with Gwen Washburn, Churchill County Commission Chairman, and Norm Frey, Churchill County Commissioner, read the following statement from Commissioner Washburn (*Exhibit L*):

> The Churchill County officials are very concerned about the welfare of the citizens. We want to explore all possible avenues that may attribute to the cause of leukemia but none of us is willing to point to any one cause. We are leaving that to the health experts.
>
> Ask 10 people on the street and we'll get 10 different opinions as to the cause of the cluster. I will attempt to address what the county is doing about some of the causes.

In Churchill County, the first thought is always water. We have been very concerned about how the reallocation of irrigation water that historically came into the valley is affecting the quality of the water being pumped from domestic wells, especially since the passage of Public Law 106–18 known as the Negotiated Settlement.

Churchill County began cooperating with the U.S.G.S. on a ground water monitoring project in 1994. In 1999, the data collection network included water level measurements at 19 wells monthly, 39 wells quarterly, and annually at 18 wells. Quality sampling and testing on five wells was done twice during the year, once during the irrigation season and once during the winter. The water was sampled for major ions, arsenic and nutrients. In the year 2000, four more wells were installed in an area slated for development where septic tanks would be used for sewage disposal to provide background data on the effect of development on water quantity and quality. Also in the year 2000, one isotope sample was obtained and analyzed at each of the five water quality wells. There's an attachment that describes some of that activity.

Realizing the potential for growth and the need to supply the community with a safe and assured water supply in the future, we have for the last several years been in the process of developing a plan for a community-wide water system. The plan is very tentative at this point and the economic feasibility study is not yet complete. We are looking at every possible source to supply this system, including Dixie Valley and the Stillwater Mountain Range. In cooperation with U.S.G.S. and Carson Water Subconservancy District, an injection and recovery experiment storing water for municipal and industrial use from Lahontan Reservoir in the Dead Camel Mountain alluvial fan will begin soon. Every aspect of the proposed water system is in the planning and study stage at this time. For all practical purposes, the water system is many years away. At this point, the cost to install the system, well over $200 million, is prohibitive for a small community. Obviously, funding is the huge hurdle for the county even after the water source is identified and developed.

In the interim we are faced with the problems here and now. Churchill Economic Development Authority, known as CEDA, is in the process of developing a vision for Fallon and Churchill County. In this process, CEDA has held three public workshops and one meeting of a committee made up of citizens from all business sectors. Water quantity and quality have been identified in every session as the top priority issue.

There is little that Churchill County can do at this juncture to improve the quantity and the quality of the water but [what] we can do, and are prepared to do, is to educate citizens about how they can help themselves. It has been suggested that we, the county, test the well water. That is not something that we can do. At our best estimate there are over 4,000 domestic wells in the county and it would be not only cost prohibitive and time prohibitive, but there are private property issues involved as well. What we are doing is telling private well owners how they can have their water tested.

We are actively encouraging the University of Nevada Extension Service to reinstate the Guard Our Local Drinking Water program known as Nevada GOLD. This is a group of volunteers dedicated to educating homeowners about their water supply. It is funded through the agricultural extension budget but has been inactive since the local water specialist became ill more than 3 years ago. At this point it is imperative that the University Extension Service reactivate this water education program. Many people move into the area and purchase their "dream" country home and they have no idea that the water comes from their own private well and they have the sole responsibility for that well. We will begin dispensing information about water safety and possible health related issues and testing labs at the local library, extension office, county administrative office, planning office, doctors' offices, and so forth.

Operations of certain businesses and industries have been blamed. Businesses and industries including agriculture, pesticide operators and dairies that locate in the area must have Churchill County business licenses and meet all the local zoning criteria as well the Nevada Bureau of Health requirements, and have all necessary permits from the Nevada Department of Environmental Protection. We are looking at ways to make the issuance of a business license contingent upon the company showing current permits from the State of Nevada.

Naval Air Station and jet fuel in particular are suspect. Even though we have a good relationship with the Navy, we have no control over the Federal facility and depend upon the Navy to protect its personnel and its neighbors from any harmful effects of their operation. We must leave investigations of the operations of the Navy in Churchill County to the experts.

The Churchill County commissioners are as concerned as any one about this leukemia cluster and will work closely with the local hospital to assist the health care professionals in the investigation to best of our ability.

Now, I would like to comment as an individual. I know that many people are quick to point to the water and water quality in the Lahontan Valley as the culprit in the present leukemia scare. I am not an expert on the water nor in the medical field, so I will not say that water is or is not the cause. I just would like to point out that I began using bottled water service at my home in 1995. This is because I felt that there was a definite deterioration in the quantity, quality and taste of my well water that like most in the valley comes from the shallow aquifer. I subscribed to the water service feeling that it was an inexpensive health insurance. At the time, I was more concerned about water-borne bacteria than heavy metals or minerals. Now, under the changing conditions in the valley, my concern about the quality of my well water encompasses more than just bacteria. At this time I can honestly say that I do not advocate anyone in the valley drinking water from their domestic well unless they have had that well tested recently and that it tested as safe to use.

The deterioration of our water quantity and quality has been significant since water right buy-out began. The safety of our water supply must remain the top priority of the community.

Personally and professionally, I thank you members of the Assembly for adding your support to our community at this especially difficult time.

This concluded the reading of Ms. Washburn's statement (*Exhibit M*).

Norman Frey, Churchill County Commissioner, spoke next, and was very concerned about the negative press that the investigation was generating and stressed that the study must be kept to a scientific and professional level. He felt that the general public had not separated the presence of arsenic in the water and the leukemia cluster.

Mr. Frey stated the government must deal with the people's perceptions in order to ease their tensions. He claimed the county might need assistance from the State to make well testing easier and more affordable for some 4,500 well owners. The county might need to set up low interest loans to purchase approved types of filtration systems for individual homes. He concluded by stressing that Churchill County is a very healthy place to live. Thousands had grown up and grown old there free of hideous disease.

Chairwoman de Braga stated that she and the committee would do whatever they could to reinstate the Nevada GOLD program at the Agricultural Extension Service. She also requested that the commissioners would present the committee with recommendations for educating the public, especially those in the Soda Lake area, where the arsenic rates were very much higher.

Assemblyman Neighbors requested to know the size of the area that contained the 4,500 wells. About 95 percent of the total population of Churchill County resided in the Lahontan Valley, which constituted Basin 101, the largest groundwater basin in the state.

Mr. Neighbors inquired, what was the current cost of testing a well? The cost appeared to be roughly $15 per item for each item on the test, less than $100 per resident. Each property sale required a complete test that cost $120.

In response to Mr. Claborn's question about increased abnormalities in animals in the county, Mr. Selinder responded that a veterinarian who had practiced in the county for many years had seen none.

Testimony came next from Dr. Bonnie Eberhardt Bob and Leuren Moret, representing Scientists for Indigenous People. Ms. Moret revealed that she had worked at the Lawrence Livermore Laboratory in California (*Exhibit N*) and had done research on the Yucca Mountain project (*Exhibit O*) and ran the sampling lab for the superfund project. She felt these hearings had been good but that air pathways and sampling of the upper dust layer in Fallon had been overlooked. She stated other items to investigate included: the incineration of out-dated munitions (some depleted uranium) at Honey Lake Depot that had sent a smoke plume over Nevada; planes returned to NAS from the Gulf War which might have had radioactive metal; the increased toxicity of highly complex and mixed compounds such as radionucleides mixed with hydrocarbons; and, burns in the fallout areas of Nevada (from the testing of the 1950's) which remobilized the radionucleides in the upper dust levels thus recontaminating some populations. Constant exposure to low-level radiation, she testified, was more dangerous than a flash exposure such as was at Hiroshima. She concluded by stating that the water in Fallon had not been tested for tritium (radioactive hydrogen), and that the city should test surface ditches and drainage for airborne radionucleides.

Dr. Bonnie Eberhardt Bob, a psycho-biologist, answered Assemblywoman Gibbons' earlier question saying yes, there was at least one Shoshone child who was quite young and has contracted leukemia.

Dr. Bob related a story of gathering pine nuts with the Shoshone last Fall in an area indicated to be "experimental tree plots" and in which the trees had been dying from the top down. After some research, Dr. Bob found that the BLM had planned to bum 870,000 acres of pinion trees in Nevada. The chemical that killed the trees, she claimed, was probably tebuthiuron, a ground sterilizing agent.

Another chemical, picloram, also known as Agent White, was one of the defoliants used in Vietnam and was now used by the U.S. government in the war against drugs in Columbia. Picloram was used to make Tordon which when mixed equally with 2–4–D plus 245T (Weedar) was Agent Orange. She concluded that, in effect, "we" are making Agent Orange again, except perhaps with the dioxins removed. Furthermore, in the Ely district where there were fires, the fields were sprayed with Garlon, which when burned "mimics estrogens and hormones of women and it ruins the reproductive system."

Dr. Bob continued her testimony and described the level of picloram in Nevada's water and wondered what the reaction was when this chemical was mixed with others and used for weed or insect control. She expressed her concern for: the burning of parts of Nevada that would release radionuclides into the air; tritium that was in the tree cellulose and was released into the air from a burning tree; and plutonium that would be released into the air when burning occurred. Dr. Bob gave the committee a letter she wrote to the Bureau of Land Management (*Exhibit P*).

Ms. Moret added that the smoke plume from the burning at the Fallon Naval Air Station should be investigated as well.

Dr. Bob ended her testimony by reading a statement from Corbin Harney, Shoshone Nation, which emphasized the importance of cleaning the earth.

Keith Weaver, a long term Fallon resident and a member of the de Braga family, delivered the final testimony. Mr. Weaver felt that the link between arsenic and leukemia should not be eliminated from examination at this point, based on a recent article he had read in the *Journal of Epidemiology*. Chairwoman de Braga agreed that the committee did not wish to rule out anything at this point.

The hearing closed at 5:23 p.m. to be resumed February 15 at 1 p.m.

Respectfully submitted,

JUNE RIGSBY,
Committee Secretary.

FEBRUARY 14, 2001

The Committee on Natural Resources, Agriculture, and Mining was called to order at 1 p.m., on Wednesday, February 14, 2001. Chairman Marcia de Braga presided in room 1214 of the Legislative Building, Carson City, Nevada. *Exhibit A* is the Agenda. *Exhibit B* is the Guest List. All exhibits are available and on file at the Research Library of the Legislative Counsel Bureau.

Committee Members Present.—Mrs. Marcia de Braga, Chairman; Mr. Tom Collins, Vice Chairman; Mr. Douglas Bache; Mr. David Brown; Mr. John Carpenter; Mr. Jerry Claborn; Mr. David Humke; Mr. John J. Lee; Mr. John Marvel; Mr. Harry Mortenson; Mr. Roy Neighbors.

Committee Members Absent.—Ms. Genie Ohrenschall.

Guest Legislators Present.—Assemblywoman Sharron Angle, District 29; Assemblywoman Merle Berman, District 2; Assemblywoman Vivian Freeman, District 24; Assemblywoman Dawn Gibbons, District 25; Assemblywoman Ellen Koivisto, District 14; Assemblywoman Sheila Leslie, District 27; Assemblyman Mark Manendo, District 18; Assemblywoman Kathy McClain, District 15; Assemblywoman Bonnie Parnell, District 40; Assemblywoman Debbie Smith, District 30; Assemblywoman Sandra Tiffany, District 21; Assemblyman Wendell Williams, District 6.

Staff Members Present.—Linda Eissmann, Committee Policy Analyst; Marla McDade Williams, Committee Policy Analyst; June Rigsby, Committee Secretary.

Others Present.—Glen Anderson, Policy Specialist, National Conference of State Legislators; Dr. Thomas Sinks, Epidemiologist, Center for Disease Control; Dr. Allan Smith, arsenic specialist, University of California, Berkeley; Brenda Gross, Fallon parent of a leukemia victim; Dr. James Forsythe, Medical Oncologist, Reno; Dr. Gary Ridenour, Fallon Physician; Diane Hansen, Fallon citizen; Peter Washburn, Attorney, Senator Harry Reid's Office; Jerry Buk, University of Nevada, Reno, Cooperative Extension; Juanita Cox, Citizen Lobbyist; Robert Sonderfan, Citizen Lobbyist.

Chairman de Braga called the Assembly Natural Resources, Agriculture, and Mining Committee to order. Roll was called, and a quorum was judged to be in place. All members were present except for Assemblywoman Ohrenschall who was noted as an excused absence. Chairman de Braga welcomed as guests the Assembly Committee on Health and Human Services. Roll was called, and all members were present.

Chairman de Braga, in her opening statements, remarked that this was the third and final day of hearings on the Fallon leukemia cluster. As with the previous 2 days, a balance of expert testimony and public input was scheduled.

Expert testimony commenced with the introduction of Glen Anderson, Policy Specialist, National Conference of State Legislators (NCSL). The role of the NCSL was described as providing assistance to State legislators on environmental health issues. Mr. Anderson distributed two handouts that outlined a list of environmental disease registry legislation by State (*Exhibit C*) and NCSL environmental projects (*Exhibit D*).

Mr. Anderson commenced his testimony with an overview of what was known about the link between environmental agents and cancer. Scientific investigation of childhood cancer was complicated by the relative rarity of cases as well as by the difficulty of estimating past exposure levels for young victims after they developed cancer.

What had been established was that children had less developed immune systems and were therefore more susceptible to the effects of toxic exposure (e.g., mercury, lead, pesticide). Childhood cancer was described as the second leading cause of death in children under age 14, with leukemia the most common type of cancer.

Human research on the link between the environment and cancer lagged behind animal research. To date, clear causes had evaded scientists in cancer cluster investigations. An extensive list of variables under investigation included long latency periods between exposure and onset of disease, the plethora of potential chemical agents, and the tendency of families to change residency often.

Disease tracking registries were described as offering the greatest hope for closing the information gap between exposure data and the cancer data. Nationwide, State disease registry information would be combined with background data on environmental exposure to promote understanding of cancer causes.

Mr. Anderson reviewed innovations made in other States. Geographic mapping was described as a significant enhancement to some State registries and promised to aid in more expeditious detection of future cancer clusters. Some States had taken a preventative approach through the introduction of children's environmental health legislation. Because most law had been designed around protection of adult health, Maryland and California were cited as two States that enacted specific health guidelines for children.

Federal efforts in the areas of children's health, the environment, and disease tracking (e.g. Center for Disease Control) had paralleled and supported the States' disease registry efforts. The Food Quality and Protection Act of 1996 resulted in the restriction of pesticide use that might cause childhood disease.

The Children's Health Act of 2000 addressed childhood cancer through the requirement of the study of environmental and other risk factors for diseases such as leukemia. A uniform reporting system to track epidemiological data was described as an essential success factor.

Mr. Anderson added that the clean up of identified environmental hazards would always be a positive side benefit to all cancer cluster investigations, even when a definitive cause for the cluster had never been found.

Chairman de Braga requested recommendations on methods for facilitating the sharing of registry data between the States. Mr. Anderson explained that there had not been a lot of work done to connect cancer cluster data. He was unsure of how a streamlined system would be designed. Chairman de Braga posed a question on the prevalence of backlog in State registries across the nation. Mr. Anderson clarified that all States had registries in place, however it was unknown about how vigilant each State was in monitoring their registry data. The scrutiny of data by any State, including the integration of geographical mapping information, would take a much greater investment of time and resources.

Mr. Anderson reassured Chairman de Braga that his agency did track the research on registry efforts in each State. Most States had not done a lot to make connections between a cancer cluster and environmental exposures. Legislative bills had been introduced, however few had been passed. On a positive note, Mr. Anderson added that awareness of the need was increasing.

Chairman de Braga expressed her appreciation to Mr. Anderson for his testimony. Before introducing the next expert, Chairman de Braga made several announcements to the committees. Senator Harry Reid's Office let it be known that a

$500,000 Federal fund would be available to help enhance the cancer registry data gathering. The second announcement was regarding the Nevada GOLD (Guarding Our Local Drinking Water) program. Jerry Buck would address a positive breakthrough on the future of this program later in the hearings.

Dr. Thomas Sinks, an Epidemiologist with the Center for Disease Control (CDC), distributed a 6-page handout (*Exhibit E*) that contained his testimony on the epidemiology of Acute Lymphocytic Leukemia (ALL) and the work of the CDC and their sister agency, the Agency for Toxic Substances and Disease Registry (ATSDR). Dr. Sinks commenced testimony with his assurance to the residents of Fallon of the CDC's deep concern over the leukemia cluster. Although causes had rarely been identified in cluster studies, the survival rate for ALL of 80 percent was judged to be a significant milestone in the cancer battle.

Dr. Sinks emphasized that the highest priorities remained the need to identify causes and prevent future occurrences. Although described as a relatively rare diagnosis in children, the national rate was known to be one case of ALL per 6,600 children. This translated to an estimated 2,400 new cases of ALL each year in the United States. Gender, age, race, and socio-economic status were highlighted as significant factors in the profile of a leukemia victim. The peak age was reported for children between the age of 2 and 5 years, with boys known to be 30 percent more likely to develop ALL. Genetic and environmental factors were judged to play a significant, but unexplained role, in the development of ALL.

Dr. Sinks continued with a list of suspected cancer-inducing factors, which included ionizing radiation, certain medical conditions (e.g., Down's Syndrome), high birth weight, maternal history of fetal loss, and birth order. Other inconsistent evidence included parental smoking, parental occupation exposure, and postnatal infection. In-utero exposure to ultrasound examinations had not been associated with ALL.

In terms of cancer prevention and control programs at CDC, support of population-based cancer registries and cancer screening efforts were described as in place across the country. The compilation of the various State registries enabled some longitudinal oversight capabilities by the CDC. Federal support in Nevada was further illustrated by $1.4 million of funding of the Nevada Cancer Registry between 1994 and 2000.

Dr. Sinks reported that CDC had participated in 108 cancer cluster field investigations, convened a national conference on the clustering of health events, published recommendations, and provided technical assistance to health departments nationwide. He expressed his concern over the tremendous amount of time and money required to conduct field investigations, with most studies revealing no conclusive findings. Positive remedial steps, however, were reported as implemented in most cases.

Chairman de Braga requested clarification of the definition of a cluster and the number of years typically involved. Dr. Sinks explained that the word cluster, from an epidemiological point, was defined as being a greater number of cases than expected statistically. The word cluster did not necessarily imply that there would be a unifying cause. He further emphasized that statistical tests looked only at probabilities of chance occurrence and did not address the likelihood of cause. CDC treated each suspected cluster as a unique situation.

Assemblywoman Berman requested clarification of the term "panel of experts" on page 6 of the handout (*Exhibit E*) and why the Federal Government was not involved in the testing. Dr. Sinks defended the practice of assembling a wide variety of medical, academic, and scientific experts for purposes of peer review. In response to the issue of Federal involvement, Dr. Sinks explained that the CDC responded to numerous requests by the invitation of States facing a public health problem. The CDC role was described as being supportive, but was not one of assuming ownership of the problem.

Assemblywoman Leslie expressed her concern that there was no formal national tracking system in place for cancer clusters. Dr. Sinks agreed that there was need for a national tracking system, but it would require higher review and authority. Additionally, it would be a difficult process to implement because of the variability of defining and identifying clusters. In response to Assemblywoman Leslie's question about a cluster being simply one of a high number of cases in a specific geographic area, Dr. Sinks explained that defining a cluster would only be the first step. It would be followed by the challenge of establishing the corrective steps needed to deal with the problem.

Dr. Sinks elaborated that, unlike breast cancer screening programs, there was no health screening program for childhood ALL. He stated that requests for cancer cluster investigations were predominantly for the more common, screenable cancers and, therefore, targeted the adult population.

To Assemblywoman Leslie's inquiry about the role of arsenic, Dr. Sinks stated that it would be impossible to say definitively that it would be associated with the Fallon cluster. It had been established that the levels exceeded acceptable amounts and that arsenic was known to be a human carcinogen. He encouraged the investigative team to pursue the examination of other agents, such as volatile organic chemicals and ionizing radiation.

Assemblywoman Gibbons expressed concern as to whether everything was being done to minimize risk and exposure. She also asked for clarification on the 20 percent mortality rate among ALL victims and the significance of the demographics (e.g., age, gender). Dr. Sinks responded that it was unknown if all preventative and remedial steps were in place. It had been established that the 20 percent mortality was seen in older victims where chemotherapy was less effective. Late diagnosis was also a negative for survival.

Clarification was requested by Assemblywoman McClain on whether the $500,000 Federal fund would be enough to bring the Nevada Cancer Registry up to date. She also expressed concern over the reported 2-year lag in the registry data and the possibility that there could be other undetected clusters. Dr. Sinks stated that the Nevada registry was average for reporting lag in comparison to other States. There were some state-of-the-art systems developed in other States. Dr. Sinks cautioned that having up-to-date cancer registries would not necessarily be the answer to early detection of cancer clusters. It would likely result in a multitude of unnecessary investigations. Generally, the registry data had been judged most useful after attention had been drawn to a suspected cluster.

Assemblywoman McClain commented on the fact that the current ALL cluster in Fallon had been identified by the smallness of the community and not by the cancer registry. Dr. Sinks concurred and added that the current study would likely spur the Nevada Health Division to look at the occurrence of ALL across the entire State. The most difficult challenge was described as being able to take data from the cancer registry and tie it directly to environmental agents.

In response to Assemblywoman Berman's question regarding statistical chance, Dr. Sinks clarified that nobody ever developed cancer because of chances. There was always a cause, and the challenge in Fallon would be to discover the common denominator among the 11 children. The unifying cause was not yet known, but eventually science would identify the commonality. The probability of the Fallon cluster being a chance event was described by Dr. Sinks as being unlikely .

Chairman de Braga raised a question about ALL cases that occurred outside of the identified cluster timeframe of 1995–1999. She requested clarification about the upcoming assignments of the panel of experts and whether two 1992 cases would be considered for inclusion in the panel's discussions. Dr. Sinks explained that the panel of experts had been assembled by the Nevada Health Division. As such, the Nevada Health Division would charge the panel with direction and recommendations for action. Dr. Sinks did agree that it would be reasonable to look at the 1992 cases to determine if inclusion would be appropriate. He referred the Chairman to Dr. Guinan for specific answers.

Assemblyman Collins posed a question about the thoroughness of the health division's investigation. In response, Dr. Sinks stated that it would be virtually impossible to look at all suspected agents. The accepted process was to narrow the list of hypotheses to a testable number and then prioritize them based on probability of involvement.

Assemblyman Collins, using the example of PCB contamination cleanup, reiterated his concern that limiting the investigation could limit the answers. Dr. Sinks stated that it would be imperative to separate the things that had been known to be hazardous but had remedial solutions versus the need to answer scientific questions that could not be answered. Preventing the next case of leukemia would remain the primary goal.

Dr. Allan Smith, an arsenic specialist with University of California, Berkeley, commenced testimony with a review of various domestic and international arsenic research programs. Dr. Smith reported on his 8-year research project in Nevada, which included a bladder cancer study. The Nevada Tumor Registry was utilized in this study as well as in a childhood cancer study.

Dr. Smith explained that most of his cancer research had been with adults and included cluster investigative work. A leukemia cluster in North Carolina was determined to be related to solvents in a tire producing plant. Most of his cluster investigations did not, however, result in the discovery of a definitive agent.

In his review of the Nevada tumor registry data for Churchill County for the years 1979 to 1999, Dr. Smith detected only two cases of leukemia. With those statistics in mind, Dr. Smith characterized the current cluster as "remarkable." Armed with the knowledge of Fallon's levels of arsenic for decades, Dr. Smith stated em-

phatically that it would be highly unlikely that arsenic would be the cause of the leukemia cluster.

In response to a question about handouts, Dr. Smith replied that he had not prepared written testimony, and he referred the committees to his Web site *www.socrates.berkeley.edu/-asrg/*.

Chairman de Braga inquired about Dr. Smith's choice of Fallon for his research studies on bladder cancer. Dr. Smith explained that Fallon was selected because the area was known to have some of the highest arsenic levels in the nation. The Fallon population was judged to be a highly exposed group. His researchers looked for genetic damage in bladder cells associated with high cancer rates.

Chairman de Braga asked if his research included the effects of arsenic on the immune system. Dr. Smith replied that it did not. His research instead focused on the end result of the cancer. He added that if he had judged it to be a high priority research question, it would have been done. The evidence was not there to support arsenic and an adverse effect on the immune system. In response to Assemblyman Collins' question regarding the difficulty of discovering combinations of causal agents, Dr. Smith acknowledged that this was a significant challenge. The synergy between two agents had been investigated, an example being the combination of smoking and arsenic. He made the distinction, however that the sudden onset of a cancer cluster was different and did not fit the classic profile of long-term synergistic effects. The sudden introduction of an environmental co-factor suggested an infectious agent, for example.

Assemblywoman Gibbons requested clarification of the list of suggested questions that was included in their information packet. Chairman de Braga explained that these were supplied as a guideline to the committee members.

Assemblywoman Gibbons posed a question about the levels of arsenic, bladder cancer rates, and cure rates in Churchill County compared with other areas. Dr. Smith clarified that typical arsenic levels in the United States were 2 micrograms per liter. Fallon, Lyon County, and Kings County, California had always tested at 90 to 100 micrograms per liter. The private wells in Churchill County revealed some of the highest arsenic levels in the world.

In response to the subject of bladder cancer incidence and cure rates, Dr. Smith described his long-term study as still in the analysis phase. A proposal for the study of lung cancer in Nevada had recently been submitted to the National Institutes for Health (NIH). Using a method called "rapid case ascertainment" with data from the Nevada Tumor Registry, Dr. Smith was optimistic of a more rapid identification of lung cancer.

Assemblywoman Gibbons requested clarification on the extremely high levels of arsenic in Fallon's private wells and the interplay between dosage and individual immunity. Dr. Smith explained that he had deliberately studied wells with the highest levels of arsenic, selecting 11 families whose wells exceeded 1,000 micrograms per liter.

Chairman de Braga added that a recurring question among the committees was the threshold amount at which arsenic became a problem. Dr. Smith elaborated that in their risk assessment studies, at 50 micrograms per liter, there was an estimated probability of 1 in 100 people dying of cancer. He concluded that it was an acceptable fact that consumption of water with 90 to 100 micrograms of arsenic was detrimental to public health.

Brenda Gross, a Fallon resident and mother of one of the leukemia victims, commenced testimony. Mrs. Gross shared the heartbreak and stress of dealing with a devastating illness in the family. She acknowledged the involvement of the Nevada Health Division and their sharing of information. Her specific concerns were centered on the difficulty of making treatment choices for her son, constantly having to weigh the side effects of treatment against the chances of death. Mrs. Gross addressed a further concern regarding the tendency to dismiss a cause, such as arsenic. She emphasized that investigation into combination agents (e.g., arsenic plus another environmental agent) would be imperative.

Mrs. Gross expressed her certainty that there was a definitive cause in Fallon, and she hoped that the Nevada Health Division would be aggressive in their pursuit of common denominators. She concluded by saying that, with only one of her four children affected, she was baffled by what would be so unique about her one son (e.g., genetic).

On behalf of both committees, Chairman de Braga expressed her sincere appreciation to Mrs. Gross for sharing her personal story. Assemblywoman Leslie reiterated her appreciation and asked Mrs. Gross if, in her judgment, the State of Nevada could be doing more for the families and the community. Mrs. Gross added that testing of private well water, soil testing, jet fuel studies and air quality studies in surrounding areas might be helpful.

Assemblywoman Leslie added that, as a minimum, establishing a central place for questions would be warranted for the community. It was emphasized that recommendations would be most welcome from the families of Churchill County.

In response to Assemblywoman Gibbons, Mrs. Gross explained that her son's chemotherapy was being done in Fallon on a weekly basis and at the University of California, Davis on a monthly basis.

Dr. James Forsythe, Reno Oncologist, was introduced as the next presenter. He distributed a handout (*Exhibit F*), a 1979 newspaper article which described a suspected cancer cluster in northern Nevada. At that time, Dr. Forsythe was one of only two oncologists in the area, the significance being that he had firsthand knowledge of every cancer case in the area. This lead to his discovery of what he considered to be a cancer cluster in the Fallon area. His concern was amplified by the Veteran's Hospital in Reno.

In 1979, an investigative study was initiated by the University of California, Berkeley, Public Health Service. Their statistical analyses revealed significant increases in brain and testicular cancer in the Fallon area. The report was delivered to the chairman of the Northern Nevada Cancer Council, Dr. John Shields, and the matter was not pursued.

Dr. Forsythe described his ongoing involvement in the diagnosis and treatment of Fallon cancer patients. He had long speculated on the commonality of the drinking water as the source of the problem, with arsenic levels at 20 times the national average. Today, Dr. Forsythe stated that his focus was diverted to contamination of water supplies by petroleum products originating in industries or perhaps the naval base.

Dr. Forsythe next shared anecdotal stories from various sources which he believed could have significance. The first point he highlighted was the high water table in Fallon (i.e., less than 50 feet) in combination with poor water quality. Second, Dr. Forsythe commented on the reported practice at the Fallon NAS of routinely spraying weeds with jet fuel. His third point centered on reports from utility inspectors excavating soil on the naval base and their observations of a petroleum stench at the 4 to 6 foot soil level. In 1995, there was an unofficial report of a large spill of petroleum products on the base. Although not revealed in the news media, the EPA did respond with remedial efforts.

Other risk factors included the atomic blast in 1963 (i.e., Shoal Project) and electromagnetic field radiation. Dr. Forsythe stated that, of all of the risk factors on a long list, childhood Acute Lymphocytic Leukemia (ALL) had been known to be induced, in part, by petroleum byproducts such as benzene and other gasoline substances. Lymphocyte assays of family members, through an analysis called ELISA, had proven to be revealing. More than 400 chemicals would be detected with ELISA methodology. Hair and urine analyses for heavy metals were also recommended by Dr. Forsythe.

Dr. Forsythe encouraged the expansion of testing by the Nevada Health Division to include the victims and families. He stated with reasonable certainty that petroleum byproducts had leached through the earth and had contaminated the high aquifers of the Churchill area. In his judgment, this would prove to be significant in the cluster investigation.

Chairman de Braga requested clarification on the 1979 cluster, specifically regarding the reaction of the medical community. Dr. Forsythe described the event as being "clinically suspicious" and was not noticed until Berkeley released their report. Chairman de Braga shared her own experience with inquiring about the cancer levels in Fallon. In reply, Dr. Forsythe expressed his disappointment in the apparent inaccuracy of the Nevada Tumor Board records. This was compounded by the fact that, in a small town like Fallon, many cancer patients left the area for treatment and were not tracked by the registry. Reporting lag time was also cited as a significant factor in the inaccuracy.

Chairman de Braga inquired about the costs and the process to test families and neighbors. Dr. Forsythe judged that it would be reasonable if a sampling of families was used and not the entire population. Hair testing would be non-invasive, and costs were estimated at $50 to $80. Urine testing for heavy metals was reported to be approximately $200. The ELISA testing for multiple chemical exposure was described as $300 to $400 per sample, but was the most diagnostic method. The latter test was based on the detection of antibodies produced by the body in reaction to various foreign substances.

In response to Chairman de Braga's question about herbicides and pesticides, Dr. Forsythe acknowledged that these substances would need to be considered, given the extensive agricultural activity in the valley. Chairman de Braga requested recommendations for how to proceed with the cluster investigation. Dr. Forsythe summarized his recommendations as: the testing of the victims for chemicals in the hair

and urine, testing a control group of friends or neighbors, and thoroughly analyzing the drinking water for all possible pollutants. Dr. Forsythe clarified that he was not familiar with the list of previously tested substances in drinking water.

Dr. Forsythe reviewed the types of cancers he had handled during the last 10 years in the Churchill County area; 40 cases of breast cancer, 30 cases of colon cancer, 35 cases of lung cancer, 15 cases of Hodgkins/Lymphoma/leukemia, 25 cases of prostate cancer, 20 cases of skin cancer, 8 cases of brain cancer, 5 cases of ovarian cancer, and 8 cases of head/neck cancers. It was notable that these were just the cases handled by Dr. Forsythe and did not include the cancer statistics from 10 other oncologists in Reno.

Assemblywoman Koivisto asked for elaboration on the microwaves from radar systems at the Fallon Naval Air Station (NAS). Dr. Forsythe stated that electromagnetic fields (EMF) must be considered, however EMF research to date was inconclusive.

Chairman de Braga introduced Dr. Gary Ridenour, a Fallon physician. He commenced testimony with the topic of jet fuel, in particular JP8. It was introduced to Fallon in 1991, and shortly after that, Dr. Ridenour noticed an immediate change in the liver function tests (e.g., liver damage) in patients. Dr. Ridenour shared his extensive research on incidents of jet fuel leakage on the base. He further stated that he had not observed intentional malice on the part of the Navy regarding the subject of jet fuel. What they know was described by Dr. Ridenour as what they were told by the Department of Defense.

Often dismissed by the military as similar to kerosene, the high toxicity of jet fuel, even in minute quantities, had been demonstrated in multiple studies and was known to provoke serious health effects including skin penetration, decreased immune system response, increase in lung permeability, and headaches, to name a few. During the 1990's, medical articles abounded on the subject of the toxicity of JP8.

In terms of fuel dumping and evaporation, the jet fuel would still exist in some form when it made contact with the earth. Dr. Ridenour cited a recent example of a cloud sighting near the base, described as a large brown vapor emitted from the startup of jets. He added that one of the biggest problems with JP8 was the low cost of 80 cents per gallon, approximately half of the cost of its predecessor fuel JP5.

JP8 had so far not been allowed on aircraft carriers, a point which Dr. Ridenour considered significant. It was utilized extensively during the Gulf War, which suggested the need to connect the fuel with the highly publicized health problems among the military personnel. Even brief contact with JPB fumes resulted in the immediate detectable presence of fuel in the breath of the person. Dr. Ridenour cited several recent research articles about the negative health effects of exposure to jet fuel.

In regard to the 6-inch fuel line that delivered jet fuel to the Fallon NAS, Dr. Ridenour described it as more than 30 years old, made of steel, and highly susceptible to corrosion and seismic activity in the desert. The integrity of the pipeline would be highly questionable. A map of Fallon displayed the path of the pipeline, described as running within 10 feet of schools in Fallon and crossing the parking lot of the new Baptist Church. The pipeline was further described as coming in contact with the Carson River and every ditch and irrigation channel across the town. In retrospect, it should have been routed around the city of Fallon, and not through it. Vents, located along the route, were visibly damaged in certain areas.

Dr. Ridenour expressed his alarm that, despite the plethora of reports and warnings about the hazards of the jet fuel, nothing was done about it. Morgan Kinder, the operators of the fuel pipeline, had some checks on the integrity of the system. Dr. Ridenour described a photo of one of the pipeline test locations. It was covered with spider webs, indicating that it had not been disturbed by personnel assigned to monitor the pipeline. Morgan Kinder supposedly used pressurization tests to detect leaks, with the problem being the unknown amount of pressure used during the test. In Dr. Ridenour's judgment, given the 300-mile length of the pipeline, it would have to be a sizable leak before it would be detected as a pressure drop. At a leakage rate of one drop per second, the soil contamination in 1 year would be 300 gallons.

Dr. Ridenour summarized by saying it generally would take 8–10 years after introduction of a toxic material before the onset of disease. In terms of what had changed in Fallon during the last 10 years, Dr. Ridenour summarized that insecticide spraying had actually declined due to fewer fields. He added there had been no increase in radar nor had there been a change in water quality. Whereas literature searches on the topics of arsenic and leukemia yielded no matches, the topics of bone marrow and JP8 fuel revealed multiple references.

Despite the military's comparison of JP8 fuel to kerosene, Dr. Ridenour cautioned the committees that it would be akin to comparing plastic explosives to play dough. He encouraged the committees to consider requesting that JP5 be pumped through the pipeline from Benecia for an interim period in order to complete testing of JP8. A determination of the complete integrity of the line was also recommended by Dr. Ridenour. Finally, the aerosol effects of the fuel should be studied in greater depth. Air currents in the desert, below 18,000 feet of altitude, were described as highly unpredictable, and jet fuel particles would be very capable of making contact with people and soil.

Dr. Ridenour reemphasized that the change in jet fuels had to be considered as one of the most significant new events during the last 10 years in Churchill County. He once again stated that the Navy itself would not necessarily be at fault if they had also been "sold a bill of goods" on the merits of JP8. Morgan Kinder should be made to reroute the pipeline around the town.

Assemblyman Carpenter inquired about the type of fuel used on commercial jets. Dr. Ridenour stated that it was Jet A, a fuel that was closer to JP4 in composition. He cautioned that, because of its economical cost, some airlines were considering switching to JP8.

In response to Assemblyman Claborn's comment about the fuel pipeline in Las Vegas, Dr. Ridenour cited the distinction between the two as being one of age, namely that the northern Nevada line was much older. The Fallon line also pumped a greater volume, estimated at more than 400,000 gallons per month.

Assemblyman Neighbors shared his confusion regarding the Helm's Pit in Reno, once the site of serious ground contamination and now a family recreational area for boating and fishing. Dr. Ridenour agreed that it was both suspicious and confusing, and it seemed highly unlikely that the fuel oil would be cleaned up in such a short amount of time.

Chairman de Braga introduced Diane Hansen, a Fallon resident. Ms. Hansen sought reassurance from the committees that a systematic and thorough cluster investigation would continue. She spoke candidly and shared her concerns that the next stage of the Nevada Health Division's investigation would not happen. Ms. Hansen expressed her expectations that a team of experts would be assembled and that this investigative team would receive specific direction and adequate manpower and funding to do the job right. She further emphasized the need for the team to ask the right questions and to be forthright in their communication with the residents of Churchill County.

Making reference to a 1996 newspaper article, Ms. Hansen shared her specific concerns about an industrial plant 12 miles north of Fallon. The New American Tec Corporation arrived in Nevada after having been cited for severe environmental contamination in Kentucky. Their chemical process, a nickel and chrome plating operation, was known to utilize known carcinogens. Ms. Hansen was especially concerned that there had been no followup publicity on this hazardous industry.

In an effort to get answers to her questions, Ms. Hansen conducted her own research and called various agencies, including NDEP, EPA in San Francisco, the Lahontan Valley News, the Reno Gazette, and the Churchill County Planning Commission. She was surprised to hear that she had been the only person to request followup information on New American Tec. What she learned was that Fallon was the only location in the Nation that utilized a vaporization process to plate copper using nickel carbonyl, a known carcinogen. There was evidence that New American Tec had not been totally forthcoming about their history in Kentucky in applying for a permit in Nevada.

Her inquiries to Nevada Department of Environmental Protection revealed that New American Tec was permitted to emit 2 pounds of nickel components per hour into the air. Neither the State nor the county required air monitoring on a regularly scheduled basis. Any air emission results were self-issued by the corporation. The possible significance of the New American Tec production startup of November 1996 should not be ignored.

In closing, Ms. Hansen asked for assurance that the investigation would include these small pieces of the puzzle, for example New American Tec.

Chairman de Braga acknowledged that Ms. Hansen represented widespread community concern and that the serious nature of the cluster dictated a very serious and thorough approach. It was explained that the role of the legislators would be to make recommendations. The expert panel, comprised of a variety of medical and scientific experts, would also make recommendations. Ms. Hansen was reassured that the Nevada Health Division was committed to doing as much as possible. Congressional, State, and community interest would propel the investigation in the right direction.

Ms. Hansen requested clarification on the issue of NDEP writing a requirement for monitoring into their permitting process. The New American Tec permit was up for renewal at the current time, and NDEP was said to be in negotiation with the attorney for the company to require monitoring activities. Ms. Hansen emphasized the sincere interest on the part of the Fallon residents to do what ever they could to help.

Assemblywoman de Braga echoed the words of Ms. Hansen and agreed that Fallon was, indeed, a wonderful community for families. She gratefully acknowledged the testimony of Ms. Hansen.

The next expert witness called was Peter Washburn, Attorney for Senator Reid's office in Washington, DC. Mr. Washburn distributed a copy of his written statements (*Exhibit G*). He commenced his testimony by highlighting Senator Reid's senior membership with the Senate Environment and Public Works Committee. Mr. Washburn assured the committees of Senator Reid's deep concern over the Fallon cluster. He commended Chairman de Braga on her foresight in scheduling the special legislative hearings and acknowledged the dedication of the two committees and Dr. Mary Guinan for their participation.

Because of Senator Reid's dual membership in both the Appropriations and Environmental Committees, he was described as being in a unique position to leverage Federal resources to aid the investigative work. Senator Reid's first priority was described as in the areas of communication, participation, and coordination. Because of the multitude of experts and citizens involved in the process, these hearings were said to set the stage for the essential communication and coordination of information sharing.

Mr. Washburn described Senator Reid's second priority as pointing to the issue of what could and should be done now to reduce environmental risk to the citizens of Fallon. Because investigative work would likely take years, remedial steps should be implemented regardless of conclusions about causal agents. He cited the example of arsenic and stated that Federal grants were forthcoming. The Small Community Safe Drinking Water Safety Act was slotted for introduction by Senator Reid. This bill would make Federal grants, not loans, available to small public water systems for purposes of improving the quality of the water.

Mr. Washburn explained that Senator Reid was planning to schedule hearings in Nevada for purposes of addressing the leukemia cluster and public health concerns. Dates and agenda would be announced. Chairman de Braga expressed her thanks to Senator Reid for his early and on-going involvement in the matter.

Chairman de Braga introduced Jerry Buk, Regional Director for the University of Nevada Cooperative Extension Service in northern Nevada. Mr. Buk addressed the Nevada Gold (Guarding Our Local Drinking Water) project in Fallon. This program was designed by a water specialist in Fallon, Mary Reed. The model employed was a "train the trainer" in which volunteers from the community were trained to share water safety information with the residents, especially those served by private wells.

Due to an unexpected illness of the project leader, the Nevada Gold project atrophied and ceased to function by May 2000. Mr. Buk explained that the program would be reinstated immediately. The first order of business was described as a compilation of all Nevada Gold information and dissemination of the data to all agencies and businesses that dealt with residents served by private wells.

Mr. Buk concluded by saying that the program was being reviewed and streamlined for implementation in March 2001. The new program would be tailored to include the leukemia cluster issue and would focus on educating citizens on the need to have water tested, as well as how and where to procure testing services.

In response to Chairman de Braga's question regarding the expansion of testing, Mr. Buk shared his knowledge of some grant money connected to a Ph.D. dissertation. This was described as a possible source of funds for actual water testing for residents. Mr. Buk cautioned that the breadth of water testing (i.e., number of substances) was overwhelming. The Nevada Gold program had looked specifically at nitrates in water, a relatively cheap and easy analysis. This was contrasted to the complexity and higher cost of testing newer substances.

The next experts to testify were Juanita Cox and Robert Sonderfan, representatives of People To Protect America and Citizens In Action. Self-described lobbyists, researchers, and investigative journalists, Ms. Cox and Mr. Sonderfan displayed a stack of articles and research information (no handouts). Ms. Cox expressed concern over the lack of discussion of the water contaminant MTBE. Added to gasoline in the late 1970's, it had now been known to cause three types of cancer in laboratory animals, including leukemia. The amount of contamination of drinking water and recreational water was described as extensive, and therefore, should be added to the Fallon testing agenda, according to Ms. Cox.

Internet literature searches revealed the 2001 military construction program for Fallon NAS, specifically the plan to replace military fuel tanks. Underground fuel tanks were described by the military as being 45 years old and having known leakage problems. The immersion of the tanks in the area's saltwater aquifer caused corrosive effects on the metal. Because contamination by various substances could be through ingestion, inhalation, or skin contact, Ms. Cox urged the expansion of testing. Fluoride was cited as an example.

Ms. Cox concluded her testimony with her observations of the 3-day hearings, described as "CYA" and damage control. Because of economic reasons or the threat of legal ramifications, some answers would never be disclosed. Massive denials and subsequent legal actions were predicted by Ms. Cox to be unavoidable.

Mr. Sonderfan commenced his testimony with a review of Project Shoal and Project Faultless. He described the hurdles and red tape he faced in researching these topics. Project Faultless was a 13-megaton detonation of a classified military warhead near Fallon. In his judgment, the military had not been forthcoming in revealing harmful practices, such as burying trash for more than 40 years. Nellis Air Force Base was described as having 30 tons of depleted uranium, with a half-life of more than four billion years.

Ms. Cox elaborated on the subject of depleted uranium and stated that the Pentagon knew in 1995 about the environmental threats posed by nuclear weapon waste. The question needed to be asked of the Fallon NAS about their use of plutonium, one of the most toxic substances known to man.

Ms. Cox concluded her testimony with an overview of other agents for investigation and testing, which included electromagnetic radiation (i.e., EMF), Agent White (i.e., Tordon), DDT, nuclear fallout, fuel dumping from jets, manganese, ethylene dibromide, and bovine leukemia viruses. Research indicated that veterinarians and dairy farmers had elevated leukemia rates. Production of milk was reportedly greater in cows infected with bovine leukemia.

Due to the lateness of the hour, Chairman de Braga interjected with a request of Ms. Cox to leave one copy of her testimony for distribution to the committees. Ms. Cox concurred and added that having her testimony cutoff would be expected especially since the topic was milk.

Mr. Sonderfan interjected with a plea for the Fallon NAS to come forward with a report of chemicals used and stored on the base. His research revealed leaking storage tanks. Arsenic, according to Mr. Sonderfan, was just a smokescreen. Leukemia was described as resulting from a one-two punch, the first being the lowering of the immune system and the second punch some exposure to a trigger agent. Bovine leukemia virus in raw milk had the capability of being transmitted to humans.

Ms. Cox interjected with comments about the synergistic effects of chemicals and environmental toxins. She further cautioned that, even if causes were suggested by a citizen, it would invite legal entanglement for years. She urged the cessation of cover-ups and human experimentation. She urged the committees to empower the community because it was most likely that the answers would come from the people. The public needed a civilian investigative board and a hotline for public input that would facilitate the reporting of environmental hazards.

Chairman de Braga explained that there was a hotline in place for citizen input. In response to Ms. Cox's concern about reporting an incidence of environmental dumping, Chairman de Braga assured the witness that the health department in each community was there to respond to these concerns.

Assemblyman Mortensen inquired if anybody in the room knew with certainty that the Fallon NAS practiced with depleted uranium shells. Chairman de Braga elaborated that this had been suggested in several letters from other concerned constituents. It would be included in the list of recommendations. A handout (*Exhibit H*) was received from the Department of Energy.

Chairman de Braga adjourned the meeting at 5:46 p.m.

Respectfully submitted,

JUNE RIGSBY,
Committee Secretary.

April, 19, 2001.

Committee on Environment and Public Works,
Washington, DC.

Subject: Fallon Leukemia Cluster

DEAR COMMITTEE MEMBERS: I am writing in response to a request for public testimony concerning factors to consider connection with the Fallon Leukemia cluster.

I would like to see this committee carefully consider the role of fire in the disbursal of hazardous materials through the environment, including fire's role in remobilized radioactive isotopes and other contaminates deposited in Nevada as a result of weapons testing. I would request the committee to consider the dangers associated with fire as a remobilizing agent of radionuclides from the Nevada Test Site and other testing ranges in the State.

During the period of above ground testing from 1951 to 1963, radioactive releases from the Nevada Test Site emitted over 12 billion curies of radioactive material into the atmosphere, 148 times as much as the nuclear disaster at Chernobyl. Other pre-1971 nuclear tests released 25,300,000 curies, and from 1971–1988, 54,000 curies were released, including the 36,000 curies from the Mighty Oak accident, which was itself 2000 times greater than the release at Three Mile Island. Over half of all underground tests have leaked radiation into the atmosphere (DOE Report on Radioactive Effluents, 1988). DOE has been out of compliance with Federal and State permit requirements in the areas of air emissions, water releases, and solid waste disposal (DOE Nevada Operations Office Five Year Plan, 1989).

There is contamination in soil, air, ground and surface water. Strong winds, common to this area of Nevada, can carry plutonium-contaminated dust across a large area. Fallout from above ground nuclear tests in the United States and other countries has radioactively contaminated the atmosphere around the Earth. Project Faultless in Hot Creek Valley was found to have caused radioactive contamination in groundwater. According to EPA Publication 520/4–77–016, cumulative deposits of plutonium (Pu–239 and Pu–240) have been found in soil over 100 miles north of the NTS at levels of 790 mg per acre. Plutonium has a half-life of 26,000 years, and plutonium contaminants ingested in microscopic amounts are capable of causing cancer for 200,000 years. There is no cost-effective technology for decontaminating such sites. No surveys have been conducted to determine health effects on Native American or other residents from Nevada Test Site (NTS) releases. Currently the Nuclear Risk Management for Native Communities project is working to answer some of these questions.

It is known that plutonium translocates to specific radiosensitive organs, especially reproductive organs.

During the years of 1999 and 2000, almost 3,000,000 acres of Public Lands in the State of Nevada were subjected to fires, both wild fire and prescribed burns. Fire remobilizes contaminants. Particles are lifted from the ground into the air, then mobilized through environment on wind currents. The particles are resuspended for an indefinite time period, finally redeposit onto the earth. This process creates fallout. As a result of this process, fire can carry containments across the globe.

We understand that the Nevada BLM oversees management of 1,722,330 acres of public lands considered contaminated with UXO, (unexploded military ordinances). BLM lands border NTS (Nevada Test Site), Nellis Bombing and Gunnery Range, Tonopha Air Force Base, together with the Fallon Range. No one knows the amount or extent of nuclear contamination in the area surrounding the NTS and Nellis Air Force Base which tests depleted uranium (DU) bombs. In 1997 it was estimated that 30 tons of DU had already been deposited in the target area (Draft Environmental Assessment Resumption of Use of Depleted Uranium Rounds at Nellis Air Force Range Target 63–10), a total of 9,500 combat mix rounds (7,900 DU rounds) being expended annually, there.

Depleted uranium or U–238 has an atomic mass of 238. Its half-life is 4.468 billion years (Rokke, 2001). It's natural occurrence is 2.1 parts per million. Uranium is silver white, lustrous, malleable, ductile, and pyrophoric. This makes DU an ideal metal for use as kinetic energy penetrators, counterweights, and shielding or armor. High density and pyrophoric (catches fire) nature are the two most significant physical properties that guided its selection for use as a kinetic energy penetrator.

A study performed at Yucca Proving Grounds found DU residues in all components of the environment, that environmental concentrations varied widely, that corroded DU residues are soluble and mobile in water, that wind dispersal during testing is the prevalent means of dispersal of DU particles, and that an unknown degree of risk was posed to human health by DU in the environment. Moreover, there appears to be no insight into the issue of long-term (100 to 1,000 years and longer). DU forms of both soluble and insoluble oxides. The inhalation of the insoluble oxides presents an internal hazard from radiation if retained in the lungs.

The long-term effects of internalized depleted uranium are not fully known, but the Army has admitted that "if DU enters the body, it has the potential to generate significant medical consequences." Inhaled DU particles or respirable size may become permanently trapped in the lungs. Inhaled DU particles larger than respirable size may be expelled from the lungs and ingested. DU may also be ingested via hand-to-mouth transfer or contamination of water or food supplies. DU, which is in-

gested, or enters the body through wind contamination, will enter the bloodstream and migrate throughout the body, with most of it eventually concentrating in the kidney, bone, or liver. The kidney is the organ most sensitive to DU toxicity.

More testing of soil and plants needs to be done to determine what radionuclides might be released into the air in a fire, since a fire and its relationship to the resuspension of contaminants has not been the subject of study. Plutonium and radionuclides concentrate in dust, thus higher concentrations are found in the dust sampling than in regular soil sampling. The standard air monitors and surface water samplers usually used are not sufficient to measure submicroscopic particles of plutonium. Further, plutonium contamination is not homogeneous, so simplistic sampling methods are inadequate (John Till, President, Risk Assessment Corp; 2000). Wind-blown particulates must be considered. Debris and gas will go somewhere, but where? Into the water or the soil?

Radiation detection devices that detect and measure alpha particles, beta particles, x-rays, and gamma rays emissions at appropriate levels from 20 dpm up to 100,000 dpm and from .1 mrem/hour to 75 mrem/hour must be acquired to assess the distribution of particles. Standard rad-meters or Geiger counters do not measure these levels.

In order to assess the health risks and damage due to exposure to tritium (radioactive hydrogen), three blood tests must be done. White blood cells must be tested for the presence of micronuclei, indicating the loss of DNA repair processes and leading to increased cancer risk. Red blood cells must be examined for genetic modification of surface glycophorin-A molecules, also indicating DNA damage. A study of Japanese nuclear bombing victims forty years from the time of the blasts showed DNA codes were still unrepaired. In addition, chromosome painting allows chromosomes to be stained for identification of structural and sequential or numerical abnormalities linked to radiation and chemical exposure, cancer, and inherited diseases.

In addition to the redistribution of containments, we need to consider the effects of fire upon other substances. For example, we must consider chemical reactions which may take place when multiple herbicides are burned together. For instance, one chemical being most often utilized on public lands is Tordon. But Tordon is also called Grazon, and the active ingredient is picloram, better known as Agent White, similar to Agent Orange, and one of several defoliants used in Vietnam. In fact, Agent White (picloram) appeared in 5 of the 15 defoliants used there. Agent White is currently being sprayed by the U.S. on the coca fields in Columbia as part of the drug war. In 1998, Dow Chemical, manufacturer of Agent White (picloram) tried to halt its use, warning that it does not bind well with soil, easily washes into the groundwater and could cause irreparable damage to the Amazon Rainforest. Yet, U.S.G.S. Pesticide 1992 Annual Use Map showed estimated annual agricultural use of Agent White to be less than 0.370 pounds per square mile per year. The map shows the entire State of Nevada has been exposed. This is a lot, and has probably increased since that time. If it's dangerous to the water and forest areas of Colombia, it is dangerous here in the U.S. The use of Tordon is banned in some countries.

Also commonly used are 2, 4–D which forms poisonous gas in fire. It is on the Hazardous Substance List because it is regulated by OSHA. The chemical is a mutagen (changes the genetic structure), a teratogen causing birth defects, and a carcinogen particularly related to breast cancer. Short term effects of its use include the death of animals, birds, fish, and plants within 2–4 days after exposure. About 91.7 percent of 2, 4–D will eventually end up in water. In 1990, the Clean Air Act announced 2, 4–D as a hazardous air pollutant. Run off vapors can kill non-target plants. Agent Orange was a mix of 2, 4–D and 2, 4, 5–T. Another name for 2, 4, 5–T is Weedar. And both of these chemicals appear on the recommended list of chemicals used on public lands.

Garlon is also known as triclopyr (both names appear separately on the recommended treatment list as if they are different herbicides). Triclopyr's chemical structure is very similar to 2, 4, 5–T. The MSDS sheet includes the following data: Nitrogen oxides, hydrogen chloride, and phosgene may result under fire conditions and NIOSH/MSHA requires approved SCBA and full protective equipment for firefighters. Garlon-treated wood that is burned during forest fires, or in wood stoves at home produces a dioxin, one of the most damaging compounds to living organisms. Garlon is an endocrine disrupter.

It mimics a plant hormone, acting systematically to kill the plant or tree. The hormone that Garlon mimics is perceived by the human body to be estrogen. In women, this may result in breast cancer, miscarriages, infertility, birth defects, and possibly ovarian cancer. In men, it can cause prostate or testicular cancer and reduction of sperm count. It also may aggravate liver and kidney disease. We do not know what

the effects of burning multiple pesticides and the full extent of the risk to public health from such events.

I suggest that a more appropriate methodology for determining causation of the Fallon leukemia clusters would use a multidimensional model for analysis. In other words, rather considering singular etiologies, as suggested by Prescott from CDC at the hearings, a more complex multi-factor dynamic process may be in operation. We might hypothesize very generally that exposure to radionuclides such as tritium, plutonium, or DU, might cause mitochondrial damage to cells. In addition to other functions, mitochondria contribute to a sort of "programmed cell-suicide". For example, in certain stages of fetal development, humans have webbed fingers. The mitochondria detect this, and at the appropriate time, seek to destroy the web cells, leaving humans with fully formed fingers. This cell-suicide is necessary.

However, when exposed to an error or to toxins or radionuclides, the mitochondria engage in a process of "unprogrammed cell suicide." Thus, healthy cells are destroyed. Such suicides may lead to destruction of critical elements of immune system function, resulting in cancers, leukemia, and the inability to fight the effects of various viruses and bacteria. The cells may be more vulnerable to effects of exposure to chemicals or pesticides. In addition, adequate production of certain neurotransmitters and hormones might be disrupted leading to diabetes or neurological damage. These medical conditions have been reported as increasing in the general population, and though differing in appearance, may be reflecting a basic underlying cellular assault caused by radiation exposure. I refer you to the work of Guy Brown.

Thank you for your thoughtful consideration.

Sincerely,

BONNIE EBERHARDT BOBB,
Shundahai Network.

STATEMENT OF GENERAL ACCOUNTING OFFICE, HEALTH, EDUCATION, AND HUMAN SERVICES DIVISION, WASHINGTON, DC.

TOXIC CHEMICALS—LONG-TERM COORDINATED STRATEGY NEEDED TO MEASURE EXPOSURES IN HUMANS

State and local officials report continuing public concern over the health risks posed by exposures to toxic chemicals, ranging from heavy metals such as arsenic found at national hazardous waste sites to common pesticides used in and around the home. For example, increasing rates of cancer in various communities have prompted questions about the potential link to residues from pesticides, indoor air pollutants, and other toxic chemicals. Historically, estimates of human exposure to toxic chemicals have been based on the concentration of these chemicals in environmental media—such as air, water, and food—along with assumptions about how people are exposed. Federal monitoring efforts have primarily focused on this type of measurement. However, according to public health experts, measurements of internal doses of exposure—actual levels of chemicals or their metabolites[1] in human tissues such as blood or urine—can be a more useful measure of exposure for some purposes.

Over the past decade, advances in laboratory technology have provided new tools for measuring a broad range of chemicals in human tissues—tools that can help researchers and health officials assess' how much of a chemical has been absorbed in the body and provide more accurate measurements of exposure to relate to potential health risks. When gathered for the U.S. population, such data can help identify new or previously unrecognized hazards related to chemical substances found in the environment, monitor changes in exposures over time, and establish the distribution of exposure levels among the general population. These data can also help identify subpopulations—such as children, low-income groups, or ethnic minorities—that might be at increased risk because they face particularly high levels of exposure. State and local health officials can use information on typical exposures in the general population to help assess environmental health risks for specific sites or populations within their borders and to keep local residents informed. For example, local officials in one community collected exposure measurements before, during, and after the burning of arsenic-contaminated soil and found that no excess exposure—as compared to typical levels found in the population—had occurred.

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[1] Metabolites result from the interaction of the chemicals with enzymes or other chemicals inside the body.

In light of the potential benefits offered by these new technologies, you asked us to review efforts to collect and use such information at both the State and Federal levels. Specifically, you asked us to (1) determine the extent to which State and Federal agencies—in particular, the Department of Health and Human Services (HHS) and the Environmental Protection Agency (EPA)—collect human exposure data[2] on potentially harmful chemicals, including data to identify at-risk populations, and (2) identify the main barriers hindering further progress in such efforts.

We compiled a list of more than 1,400 naturally occurring and manmade chemicals considered by HHS, EPA, and other entities to pose a potential threat to human health. These included chemicals prioritized for safety testing (based on EPA's findings that the chemicals may present unreasonable health risks), chemicals linked to cancer, toxic chemicals frequently found at Superfund sites, and certain pesticides monitored in foods or thought to be potentially harmful to humans. For these chemicals, we assessed the extent to which major HHS and EPA survey efforts—specifically HHS' National Health and Nutrition Examination Survey (NHANES) and EPA's National Human Exposure Assessment Survey (NHEXAS) phase I (pilot surveys)—were collecting human exposure data. We also surveyed 93 environmental health officials in 50 States and the District of Columbia, receiving responses from 81 officials in 48 States for a response rate of 87 percent. At the Federal level, we focused on survey data collected for the general (non-occupationally exposed) population. We excluded federally sponsored academic and private sector research. Appendix I explains our scope and methodology in more detail. We conducted our work from March 1999 through March 2000 in accordance with generally accepted government auditing standards.

RESULTS IN BRIEF

Federal and State efforts to collect human exposure data are limited, despite some recent expansions. HHS and EPA have been able to take advantage of improved technology to measure exposures for more people and for a broader range of chemicals. Still, with existing resources, HHS and EPA surveys together measure in the general population only about 6 percent of the more than 1,400 toxic chemicals in our review. For those toxic chemicals that we reviewed, the portion measured ranged from 2 percent of chemicals prioritized for safety testing to about 23 percent of those chemicals most often found at Superfund sites and considered to pose a significant threat to human health. Even for those chemicals that are measured, information is often insufficient to identify smaller population groups at high risk, such as children in inner cities and people living in polluted locations who may have particularly high exposures. At the State level, efforts are similarly limited. Almost all State officials who we surveyed said they highly valued human exposure data for populations within their borders, and many provided specific examples of how such data have provided useful information for interpreting citizens' health risks and guiding public health actions. For example, State officials in nine States used human samples not only to identify who was exposed to a toxic pesticide illegally sprayed in citizens' homes, but to identify houses most in need of clean-up. Despite this perceived value, most officials reported that they were unable to collect or use human exposure data in most of the cases where they thought it was important to do so.

Three main barriers limit Federal and State agencies' abilities to make more progress. First, Federal and State laboratories often lack the capacity to conduct measurements needed to collect human exposure data; additionally, for most of the chemicals on our list, no laboratory method has been developed for measuring the chemical levels in human tissues. The second barrier, particularly voiced by State officials, relates to the lack of information to help set test results in context. Public health officials said they need more information on typical exposures in the general population so that they can compare this information with people's levels at specific sites or with specific populations in their States. They also said they needed more research to relate exposure levels to health effects for the chemicals of concern in their States. The third barrier, of particular concern at the Federal level, is that coordinated, long-term planning among Federal agencies has been lacking, partly because of sporadic agency commitments to human exposure measurement and monitoring. HHS and EPA officials indicated that they have been discussing the merits

[2] The scientific community uses varying terminology when referring to human exposures. Often, external contacts with chemicals are defined as "exposures," and internal measurements of exposure are referred to as "doses." Doses are also considered a measure of exposure. Our review focused primarily on efforts to gather internal exposure measurements through human tissue in the non-occupationally-exposed population. To simplify reporting, we are referring to such internal exposure measurements as "human exposure" data.

of establishing a coordinated interagency human exposure program, but they have not yet formalized or agreed upon a long-term strategy. A long-term coordinated strategy should also ensure adequate linkages between collection efforts and agency goals, provide a framework for coordinating data collection efforts that considers individual agencies' needs and expertise, provide a framework for identifying at-risk populations, and consider States' needs for information. To address these needs, we are recommending that the Secretary of HHS and the Administrator of EPA develop a coordinated Federal strategy for the short- and long-term monitoring and reporting of human exposures to potentially toxic chemicals.

BACKGROUND

EPA projects a continuing upward trend in environmental compliance costs for pollution control measures, amounting to an estimated $148 billion this year. Hundreds of millions of dollars are spent monitoring levels of toxic chemicals in the environment—for example, approximately $139 million of Federal funding supported national air-quality monitoring networks in the United States in fiscal year 1999.[3] Despite these expenditures, what often is not known is the extent to which people are exposed to potentially harmful chemicals in their daily lives, the chemicals to which they are most often exposed, the levels of such exposure, how exposures change over time in relation to regulatory policies, and the sources of exposure. Policymakers, regulators, researchers, and public health officials must often rely on estimates of human exposure levels for the general population or for smaller groups thought to be at risk. Such estimates are often derived from data showing the extent the chemicals are found in the air, water, food, or other environmental media and assumptions about how and at what rate the body absorbs the chemicals it contacts. A variety of methods for measuring exposures are considered to be more direct than those that measure chemicals in the ambient environment. These methods measure exposures in people's more immediate environments and include tools such as personal air monitors, which measure chemicals that may be inhaled. For several chemicals and purposes, measuring internal exposure levels in human tissues is considered the most useful and accurate measure and an important piece of the information needed to link contaminants in the environment with adverse health effects.

While officials may be able to collect internal exposure levels at a local level, the results are difficult to interpret without information such as comparative data to show what exposure levels might be considered high or research findings linking exposure levels to specific health effects. Because of the need for improved data on actual human exposures found in the general population, the National Research Council (NRC), an arm of the National Academy of Sciences, recommended in 1991 that the Nation adopt a new program to monitor chemical residues in human tissues, such as blood. NRC noted that determining the concentrations of specific chemicals in human tissues could serve to integrate many kinds of human exposures across media such as air, water, or food and over time. As one component of an effort to manage environmental quality and protect public health, NRC reported that a well-designed national program for monitoring toxic chemicals in human tissues was needed.[4] NRC pointed out that human exposure data could be used to help monitor changes in the population's exposure to chemicals and identify population groups—by factors such as age or geographic location—that might be at increased risk because they face higher levels of exposure.

Direct biological monitoring of human exposure to chemicals has been made increasingly possible by recent advancements in analytical chemistry and molecular biology. Methods have been developed to measure smaller levels of toxicants in body tissues and to do so with smaller sample amounts.[5] For example, a few years ago a laboratory would need 100 milliliters of blood to detect dioxins in the part-per-billion range. New test methods use less than 10 milliliters and are capable of

[3] *The Role of Monitoring Networks in the Management of the Nation's Air Quality*, National Science and Technology Council, Committee on Environment and Natural Resources, Air Quality Research Subcommittee (Mar. 1999).

[4] According to NRC, human monitoring data alone can signal the need to conduct studies on specific environmental chemicals, but these data are best viewed as one component of a comprehensive environmental monitoring program. Human measurements are best supplemented with knowledge of contaminant sources, environmental pathways, environmental concentrations, time patterns and locations of exposure, routes of entry into the body, material toxicity, and latency. See NRC, Commission on Life Sciences, *Monitoring Human Tissues for Toxic Substances* (Washington, DC.: National Academy Press, 1991) .

[5] Other human biological tissues that might be used for measurements of chemical concentrations include fat tissue, breast milk, semen, urine, liver specimens, hair, fingernails, or saliva. Human breath has also been used to measure exposure to certain chemicals.

detecting concentrations in the parts-per-trillion range. Single samples can also now be used to detect low concentrations of multiple chemicals. Since 1995, for example, laboratory methods have been developed to detect polycyclic aromatic hydrocarbons, a group of more than 100 chemicals formed during the incomplete burning of coal, oil, gas, garbage, tobacco, and other substances.

Lead is an example of a chemical that has been monitored extensively by measuring absorption into human tissues—specifically, lead levels in the blood. Elevated levels of lead in the blood can cause learning problems and, at extreme levels, result in serious brain or kidney damage. Data on blood lead levels have been collected for the national population since 1976. Public health officials, researchers, and others have used lead exposure data from large- and small-scale studies in many ways to identify at-risk populations, evaluate regulatory actions, improve the models used to estimate exposure, and identify significant sources of preventable exposure, as shown in the following examples.

• Identifying at-risk populations: National blood lead data revealed that low-income children living in houses built before 1946 had a prevalence of elevated blood lead levels of 16.4 percent as compared to 4.4 percent for all children ages 1 through 5; non-Hispanic black children in similar housing had a prevalence of 21.9 percent—the highest risk of elevated blood lead levels of any demographic group. Using this information, State and local health of officials can more effectively target screening and treatment efforts.

• Establishing and evaluating public health-related policies: In the 1980's, EPA was considering whether or not to make permanent a temporary ban on lead in gasoline. National data on lead exposure showed a decline in average blood lead levels that corresponded to the declining amounts of lead in gasoline. Based on this and other information, EPA strengthened its restrictions on lead in gasoline and required a more rapid removal of lead from gasoline.

• Improving models used to estimate exposure: Experts indicate that an increasingly important use of human exposure data has been as a "reality check" on other indexes of exposure, such as questionnaires about activities or work histories, to ascertain whether exposures may have occurred. For example, prior to the decision to phaseout lead in gasoline, exposure models suggested that eliminating lead in gasoline would have only a slight effect on blood lead levels, while actual testing showed a more dramatic effect.

• Identifying key sources of exposure: When combined with other exposure data, exposure measurements can help reveal the source of the exposure—an essential step in developing and monitoring intervention strategies designed to reduce or eliminate harmful exposures. For example, when no evidence of lead paint—the most common source of lead contamination—was found in the home of a child whose blood showed abnormal levels of lead, public health officials were baffled. Observational data on how and where the child spent time and environmental data from the surfaces most often encountered revealed that lead-contaminated stuffing in a toy the child chewed likely accounted for the high exposure. The child's blood lead level declined when the contaminated toy was removed.

While lead is unique among chemicals in that it has been extensively studied—decades of research has shown its harmful effects at increasingly lower levels—such research has been possible in part because of laboratory advances in measurement technology. Over the years, as technology improved the ability to measure smaller and smaller amounts of lead in the bloodstream, researchers have been able to identify increasingly subtle adverse effects by linking blood lead levels and changes in neurobehavioral functioning.

CURRENT MEASUREMENT EFFORTS COVER FEW CHEMICALS AND SITUATIONS

Although HHS and EPA each are expanding their survey efforts to use new technologies and measure a broader range of exposures in the national population, their measurement efforts cover a limited portion of the more than 1,400 potentially harmful chemicals we reviewed. These surveys also remain of limited value for identifying at-risk populations, because in the case of their survey efforts, sample sizes to date have been insufficient—and, for most chemicals, not representative of the general population. In addition, Federal efforts to help assess potential disproportionate exposures by collecting data on communities living near Superfund sites have been limited to few locations. State agencies reported that their efforts are also limited, despite the importance they place on using such data in their studies of population- or site-specific situations within their borders. According to State environmental health officials, they are often unable to collect these data.

Federal Efforts Are Expanding

In our examination of the HHS and EPA surveys, we found that the types of chemicals measured have recently increased. For the past 40 years, HHS' Centers for Disease Control and Prevention (CDC) has collected through a survey nationally representative data on the health and nutrition of the U.S. population. Exposure measurements are one component of this survey. In the mid-1990s, EPA's Office of Research and Development initiated a human exposure survey, which is currently in its pilot phase in three locations across the country. A third more recent effort to monitor human exposures to select chemicals was initiated in 1996 by HHS' National Institute of Environmental Health Sciences (NIEHS) of the National Institutes of Health (NIH). For each of these Federal efforts, laboratory measurements are largely conducted by the laboratory at CDC's National Center for Environmental Health, which also developed many of the methods for performing these measurements.

CDC's National Health and Nutrition Examination Survey

CDC collects human exposure data as part of NHANES, which has been conducted periodically since 1960 and, beginning in 1999, has been conducted annually. NHANES monitors trends in health status by conducting interviews and physical assessments on a nationally representative sample of about 5,000 people per year. NHANES collects blood and urine samples for many purposes, such as assessing cholesterol levels and the prevalence of diabetes. Since 1976, these samples have also been used to measure exposure to selected chemicals, and excess samples are banked for future research. In the past, CDC's human exposure monitoring efforts have focused largely on lead, cadmium, and a few pesticides and volatile organic compounds—chemical compounds which include a number of animal and known or suspected human carcinogens found in tobacco smoke, building supplies, and consumer products.[6] Starting with the 1999 NHANES, CDC proposed to measure up to 210 chemicals in human tissues as staff and other resources permitted. These chemicals include metals such as mercury, which at high levels may damage the brain, kidneys, and developing fetus; polyaromatic hydrocarbons (a group of compounds found in sources such as foods that have been grilled); and volatile organic compounds, such as benzene. At the time of our review, a CDC official indicated that resources allowed them to include about 74 chemicals for 1999 and 2000. The estimated marginal costs for the environmental exposure-related components of the NHANES 1999 survey were about $5 million.

EPA's National Human Exposure Assessment Survey

To expand upon and replace its National Human Adipose Tissue Survey (NHATS)—a tissue monitoring program, which ended in 1992–EPA initiated in 1993 pilot surveys for NHEXAS in three regions of the country.[7] A goal of the NHEXAS pilots is to obtain knowledge on the population's distribution of total exposure to several classes of chemicals and to test the feasibility of collecting representative survey data on people's total exposures. NHATS focused on monitoring human fat tissues for persistent organochlorine pesticides and polychlorinated biphenyls (PCB); NHEXAS has broadened this focus in two ways. First, in addition to measuring chemical levels in samples such as blood or urine, the NHEXAS pilot surveys included measurements of chemicals in air, foods and beverages, water, and dust in individuals' personal external and internal environments. To conduct these measurements, the pilot surveys used tools such as questionnaires, activity diaries, air-monitoring badges worn by the individual or other air-monitoring devices, and tap and drinking water and food samples. Such data are important for purposes such as identifying the most important sources or routes of exposure and for taking actions to reduce or prevent exposures. Second, the NHEXAS pilot surveys included more types of chemicals than pesticides, such as lead and other heavy metals. The NHEXAS pilots, however, included fewer chemicals than its predecessor—which measured about 130 pesticides and PCBs in human fat tissue—in part because monitoring levels of any given chemical in personal environments and in human tissues requires significantly more laboratory measurements for the same chemical. EPA's NHEXAS pilot surveys, which have tested biological samples from about 460 participants, have collectively measured up to 46 chemicals, including pesticides, heavy

[6] Special reference studies supported by the Agency for Toxic Substances and Disease Registry were also conducted on nonrepresentative samples of a portion of the people participating in the most recently completed segment of NHANES (conducted from 1991 through 1994). These special studies assessed exposure to 45 pesticides and volatile organic compounds.

[7] Specifically, pilot surveys were conducted in Arizona, Maryland, and, EPA's region 5 (Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin).

metals, and volatile organic compounds in blood, urine, or hair. Once data from these pilot surveys have been further analyzed, EPA intends to assess the feasibility and cost of conducting a national effort to collect total exposure data. To date, EPA has invested about $20 million to support the pilot surveys. Very preliminary estimates by EPA for a national survey range from $20 million to $30 million per year over 10 years or more.

National Institute Environmental Health Sciences' Human Exposure Initiative

In 1996, NIEHS began an initiative to collect human exposure data. This initiative was started as a collaboration between NIEHS and CDC to improve understanding of human exposures to hormonally active agents—also called "environmental endocrine disrupters"—for the national population.[8] The effort was intended to build upon the chemical monitoring in NHANES by supporting the development of laboratory methods and measurement of previously unmeasured chemicals in human tissues collected from NHANES and other studies. NIEHS and CDC signed an interagency agreement, under which CDC will develop methods for measuring and will measure in blood, urine, or both up to 80 chemicals thought to be hormonally active agents. For this effort, CDC obtained samples of about 200 people—most of whom are from the ongoing sampling of the general population under NHANES.

In 1999, officials of NIEHS and the National Toxicology Program (NTP)—an interagency effort to coordinate toxicological research and testing activities of HHS, which is administratively housed at NIEHS—proposed to expand upon the initial collaboration and formalized the undertaking as the Human Exposure Initiative. Specifically, they proposed a broader interagency effort to quantify human internal exposures to chemicals released into the environment and workplace. One significant purpose of this effort was to help prioritize those chemicals and chemical mixtures to be studied by NTP, recognizing the limited resources available for toxicological testing and the need for better information to prioritize which chemicals should be tested. According to NTP officials, although NTP is the nation's largest Federal toxicology testing program, it can initiate only 10 long-term cancer studies and 10 reproductive studies per year.[9] NIEHS provided a list of 131 chemicals it hoped would be measured through this expanded effort. At the time of our review, however, program officials told us that NIEHS had not published data from the chemicals CDC had measured under this agreement, and CDC was developing the laboratory methods needed to measure many of the chemicals identified by NIEHS as needed.[10] (For more information on NHANES, NHATS, NHEXAS, and NIEHS' Human Exposure Initiative, see app. II.)

Despite Expansion, Chemicals Covered in Exposure Measurements Remains Limited

Despite these expanded efforts, NHANES and the NHEXAS pilot surveys cover only about 6 percent (or 81) of the 1,456 potentially harmful chemicals in our review. We compared the chemicals measured by these surveys to eight selected lists of chemicals of concern.[11] Our selection was based, in part, on our assessment and input from experts that these lists contained chemicals of higher concern to human health.[12] However, the listed chemicals represent a small portion of those that are

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[8] The concern about endocrine disrupters originated from the finding that some synthetic chemicals in the environment are associated with adverse reproductive and developmental effects in wildlife and mimic the actions of female hormones. According to NRC, although it is clear that exposures to hormonally active agents at high concentrations can affect wildlife and human health, the extent of harm caused by exposure to these compounds in concentrations that are common in the environment is debated. See NRC, Commission on Life Sciences, *Hormonally Active Agents in the Environment* (Washington, DC: National Academy Press, July 1999).

[9] According to NTP officials, chemicals are tested for cancer and noncancer endpoints—including effects on reproduction, development, nervous system, and immune systems—using traditional bioassays as well as newly validated tests. Validation of new tests is achieved through an NTP interagency center involving 15 Federal agencies or institutes.

[10] CDC officials indicated that, by the end of 1999, it had developed laboratory methods to measure more than half of the chemicals under the agreement with NIEHS.

[11] "We excluded NHATS and Human Exposure Initiative chemical lists from our analysis. NRC's 1991 review of the NHATS program raised questions about the representativeness of the results and the methods used to handle the tissue specimens, among other questions. The Human Exposure Initiative measurements were not available at the time of our review and, thus, which chemicals had been or are currently being measured was not known.

[12] We selected these lists based on input from program officials and experts at EPA, HHS, the Association of Public Health Laboratories, and the Pew Commission on Environmental Health and our assessment that the criteria for listing a chemical demonstrated that exposure could potentially be harmful to humans. There are many toxic chemical lists maintained by different programs and agencies for different purposes that we did not include in our review and,

regulated or are of potential public health importance. For example, there are over 7,000 lists of chemical substances and classes that are regulated under the Toxic Substances Control Act and the Emergency Planning and Community Right-to-Know Act.

For those individual lists that we reviewed, the portion of toxic chemicals measured ranged from 2 percent of chemicals prioritized for safety testing (based on EPA's findings that the chemicals may present unreasonable risks) to about 23 percent of chemicals most often found at the nation's Superfund sites and identified as posing the most significant threat to human health. See table 1 for each of the lists reviewed and the extent to which NHANES or the NHEXAS pilots are measuring these chemicals, and appendix I for a discussion of each list included in our review.

Table 1.—Extent to Which Human Exposure Data Are Collected for Potentially Harmful Chemicals Through NHANES or the NHEXAS Pilot Surveys

Priority chemicals		Chemicals measured or being measured	
Description of list	No. in list	No.	Percent
Chemicals found most often at the national Superfund sites and of most potential threat to human health	275	62	23%
EPA's list of toxics of concern in air	168	27	16
Chemicals harmful because of their persistence in the environment, tendency to bioaccumulate in plant or animal tissues and toxicity	368	52	14
Pesticides of potential concern as listed by EPA's Office of Pesticide Programs and the U.S. Department of Agriculture's Pesticide Data Program	243	32	13
Chemicals that are reported in the Toxic Release Inventory; are considered toxic; and are used, manufactured, treated, transported, or released into the environment	579	50	9
Chemicals that are known or probable carcinogens as listed in HHS' Report on Carcinogens [a]	234	17	7
Chemicals most in need of testing under the Toxic Substances Control Act (Master Testing list)	476	10	2

Note: Our analysis was based on human exposure data collected through NHANES or the NHEXAS pilot surveys through 2000.

[a] The Report on Carcinogens list may also include pharmaceutical agents, substances of primarily occupational concern, and banned substances. According to NIEHS officials, this may account for their lower inclusion in NHANES or the NHEXAS pilots. NIEHS and NTP officials indicated that, in addition to these chemicals, NTP reports results of its chronic bioassays for cancer in its technical report series. There are now approximately 500 reports, which collectively include nearly 250 chemicals found to cause cancer in rodents. Officials indicated that another useful evaluation would assess the proportion of rodent carcinogens for which human exposure data are collected and that NTP is planning to conduct such an evaluation.

While many potentially harmful chemicals in these lists are not measured in the population, NHANES or the NHEXAS pilot surveys contain a greater portion of chemicals considered of higher priority. Two toxic chemical lists we reviewed—one ranking chemicals frequently found at Superfund sites and one ranking selected chemicals compiled by EPA—prioritized chemicals based on their potential to harm human health We examined the highest-ranked chemicals on these lists and found that higher proportions of these chemicals were or will be measured compared to the overall list. A CDC laboratory official also indicated CDG was in the process of developing methods to measure a number of the chemicals on these lists and planned to measure other chemicals in future efforts if they have adequate resources to do so.

• Ranking of chemicals frequently found at Superfund sites: Developed by EPA and HHS' Agency for Toxic Substances and Disease Registry (ATSDR), which conducts public health assessments or other health investigations for populations living around national Superfund sites, this list ranks substances that are most commonly found at Superfund sites and pose the most significant potential threat to human health due to their known or suspected toxicity and potential for human exposure. Of the top 40 chemicals on this list, CDC indicated that 9 were currently being measured in NHANES. CDC hopes to include an additional 30 of the top 40 in future efforts; 11 of these 30 chemicals, however, were included in the NHEXAS pilot surveys.

• Ranking of selected toxic chemicals compiled by EPA: These rankings are based on a chemical's persistence, tendency to accumulate in plants and animals, and toxicity. CDC indicated 4 of the top 22 chemicals on this list based on their health haz-

as such, the ones we reviewed do not necessarily individually or collectively represent the chemicals of highest concern to human health.

ard[13] were currently being measured in NHANES. CDC hopes to include the remaining 18 in future efforts; 6 of the 18 chemicals were included in the NHEXAS pilot surveys.

Federal Efforts Are Limited for Identifying At-Risk Subpopulations

In recent years, Federal agencies have been charged with identifying whether certain populations—including minorities, people with low incomes, and children—disproportionately face greater health risks because they have greater exposure to environmental hazards.[14] Researchers increasingly recognize that the scarcity of adequate and appropriate data, especially for exposures and related health effects, hinders efforts to more systematically identify groups that may be at risk.[15] Lacking such data, past efforts to identify the exposures of certain demographic groups have often relied on measures of chemical levels in the surrounding environment. For example, some studies around hazardous waste sites and industrial plants have shown that minorities and low-income subpopulations are disproportionately represented within the geographic area around the sites. Such studies are limited in identifying the actual health risk because they must make assumptions about how these substitute measures, such as how close one lives to a hazardous waste site, relate to actual exposures experienced by people.

To identify groups whose exposure is disproportionately greater than that experienced by the remainder of the population—and thereby provide more definitive assessments of whether certain groups potentially face greater health risks—health officials and researchers might measure exposure levels for (1) a representative sample and analyze the characteristics of subpopulations with the highest exposures or (2) a population thought to be at high risk and compare it to measurements from a reference population.[16] We examined the extent to which Federal survey data on human exposures collected to date could be used to assess characteristics of those groups most exposed. We also examined the extent to which human exposure data was collected on a population considered to be at higher risk—specifically, those living around national priority hazardous waste sites. In each effort, the information collected has been limited, as discussed below.

Sampling Not Sufficient to Identify Many Highly Exposed Groups

Representative sampling is required to identify at-risk subpopulations in a nonbiased way—that is, without presupposing that a certain group is at higher risk. The sample must also be large enough to ensure highly exposed subpopulations can be objectively identified.[17] For nearly all chemicals except lead, however, past Federal collection of human exposure data in NHANES and the NHEXAS pilot surveys has been insufficient to identify whether disproportionate exposures are occurring in many demographic groups. In the case of NHANES, the sample is generally drawn to reflect the national population as a whole.[18] Consequently, the sample of the group of interest may be too small to draw meaningful conclusions about characteristics, such as exposures, of the group. In the past, most NHANES exposure measurements were conducted among non-randomly-selected samples and from only a portion of the surveyed participants, thus limiting the ability to identify highly exposed groups. Lead was an exception. Data for blood lead levels in children have been the most comprehensively collected, and certain characteristics have been clearly associated with a higher prevalence of blood lead levels. EPA has concluded

[13] EPA's prioritized chemical list ranks chemicals based on the length of time to break down, the degree to which they accumulate in plants and animals, and their toxicity. Both ecological and health risk scores are calculated. We used only the health risk scores in our analysis.

[14] Executive Order 12898 requires that each agency identify and address as appropriate disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions. Executive Order 13045 established similar requirements with respect to children.

[15] S. Perlin, K. Sexton, and D. Wong, "An Examination of Race and Poverty for Populations Living Near Industrial Sources of Air Pollution," *Journal of Exposure Analysis and Environmental Epidemiology,* Vol. 9, No. 1 (1999), pp. 29–48.

[16] D. Wagener, D. Williams, and P. Wilson, "Equity in Environmental Health: Data Collection and Interpretation Issues," *Toxicology and Industrial Health, Vol. 9, No. 5 (1993), pp. 775–95.*

[17] The feasibility of using a representative survey to identify at-risk subpopulations based on individual characteristics (such as age, race, or income level) or location (such as a city, county, or State) depends on sample design and size—that is, on how the participants are selected and how many participants are included. Generally, the lower the percentage of the population in question in the sample, the less the data can be used to develop precise estimates of exposure or to distinguish exposure levels between subgroups.

[18] Certain groups may be included at a higher rate or oversampled to ensure a greater level of accuracy. For example, between 1988 and 1994, children ages 2 months through 5 years surveyed in NHANES were oversampled.

that the evidence is unambiguous: children of color have a higher prevalence of elevated blood lead levels than white children do, and children in lower-income families have a higher prevalence than children in higher income families. See table 2 for the most recent NHANES analysis.

Table 2.—Prevalence of Elevated Blood Lead Levels in Children Ages 1 Through 5, by Selected Demographic Characteristics (NHANES, 1991 Through 1994)

Characteristic of children in sample	Percentage with elevated blood lead levels
Race/ethnicity:	
Black, non-Hispanic	11.2%
Mexican-American	4.0
White, non-Hispanic	2.3
Income level:	
Low	8.0
Middle	1.9
High	1.0
Age group:	
1 through 2	5.9
3 through 5	3.5
Total age 1 through 5	4.4%

Source: CDC, ''Update: Blood Lead Levels—United States, 1991–1994,'' ''Morbidity and Mortality Weekly Report, Vol. 46, No. 7 (1997), pp. 141–5.

CDC officials told us that representative data, such as that collected for lead, would be collected for a larger number of chemicals starting in 1999. However, CDC plans indicated that for most chemicals monitored, only a portion of NHANES survey participants—generally one-third or fewer, depending on the type of chemical—would be tested. For some chemicals, only certain groups thought to be at higher risk may be tested. For example, NHANES will include measurement of certain persistent pesticides known as organochlorines in one-third of the survey participants ages 12 through 19. Children under 12 will not be assessed.[19] CDC officials indicated that people over 19 may be assessed if adequate resources are available to do so. Although most organochlorines are banned in the United States, some are still used in home and garden products, such as products for treating lice and controlling agricultural and structural pests and flame retardants used in synthetic fabrics.[20] NHANES data from a one-third subsample will be useful for establishing reference ranges within the population and illuminating exposure levels nationally; they will also be useful for identifying exposures of broad demographic groups, such as males and females. But these data are not enough to enable researchers to assess exposure levels of or characterize many potentially at-risk groups, such as the exposures of inner-city children in low-income families.[21] According to a CDC laboratory

[19] According to CDC officials, children under 12 will not be assessed because the volume of tissue samples needed to perform the measurement will not be available. Other measurements—such as those for lead, mercury, and cotinine (a metabolite of nicotine illustrating exposure to cigarette smoke)—will be performed for many in this age group.

[20] According to CDC laboratory officials, other NHANES exposure measurements planned for 1999 and 2000 for a subsample of participants includes volatile organic compounds, mercury, nonpersistent pesticides, phthalates, and trace metals. Air toxic exposures to selected volatile organic compounds will be measured in personal measurements—such as chemical levels in the air, measured through badges, and chemicals in water samples—and in blood samples from a subsample of people ages 20 through 59. Mercury will be measured in the hair and blood of participants ages 1 through 5 and women ages 16 through 49. Nonpersistent pesticides or their metabolites are planned for measurement in one-half of participants ages 6 through 11 and one-third of participants ages 12 and over. Surveys and focused research indicate that household use of certain pesticides may be extensive, but little information is available concerning residential or household exposures among the general population. Phthalates are planned for measurement in one-third of the participant ages 6 and older. Seventeen trace metals will be measured in one-third of participants ages 6 and older. Trace metals such as barium and beryllium have been associated with adverse health effects in occupational or laboratory studies but have not been monitored in the general population.

[21] The current design of NHANES samples allows several years of data to be combined. If exposure for chemicals is measured consistently over several years, then assessing risk factors may be increasingly possible over time. CDC officials indicated that for any annual NHANES

Continued

official, targeted studies should be considered for groups that represent a small portion of the population.

Similarly, the NHEXAS pilot surveys included representative samples of participants in the three geographic locations covered. However, because of the smaller sample sizes, the work to date has also been too limited for much analysis of at-risk populations.[22] The pilot surveys included biological measurements for about 200 people in six Midwestern States, about 180 people in Arizona,[23] and about 80 people in Baltimore.

Federal Efforts to Identify Communities of Concern Valuable, but Human Exposure Data Are Limited

A second method to identify a subpopulation disproportionately at risk of adverse health effects is to compare exposure levels for a group thought to be at high risk with baseline measurements from a reference population.[24] This method can be used to determine, for example, the extent to which people in a neighborhood, community, or geographic location are exposed relative to others. In cases where exposure levels have been identified as high compared to reference populations but potential health effects associated with those levels have not been researched, public health actions can help prevent further or increasing exposures, and these groups can be assessed for any subsequent health outcomes.

One Federal effort, conducted by ATSDR, analyzes risks faced by communities near hazardous waste sites. ATSDR estimates that 12.5 million people live within 1 mile of the nation's 1,300 Superfund sites. The agency can collect biological samples through exposure investigations as part of the public health assessment process or in response to requests from the public.[25] ATSDR officials said that human exposure data collected at Superfund sites have been useful in deciding on actions such as stopping or reducing exposures, relocating residents, referring residents for medical follow-up, reducing community anxiety, influencing priorities on site-specific clean-up, making referrals to researchers for assessing health links, and educating community and other health providers. As evidence, they pointed to the conclusions of an expert review panel, which stated in March 1997 that human exposure data were as important to exposure investigations and public health assessments as environmental monitoring results at the sites of concern.[26] However, the number of investigations that included human exposure data has been limited. Between 1995 and July 1999, ATSDR had gathered biological samples at only about 47 of the more

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full sample, a limited number of estimates for broad population subgroups can be developed. More detailed measures for smaller subgroups (for example, analyses by age, gender, and race and ethnicity) will require more years of data, generally 3 through 6 years—and even longer if a subsample is used—of data collected for all participants. Based on an annual sample of one-third of the participants, CDC indicated that estimates may be possible for very broad subgroups, such as males or females; participants ages 6 through 19 or over 20; or a few major race and ethnicity groups, depending on the prevalence of the condition examined.

[22] One assessment of the data from Midwestern States provided some indication of potential differences in personal exposures between age groups, races, income segments, and house construction dates. Researchers cautioned that the data for some categories examined were small. This assessment did not report on exposure measurements from biological sampling in this survey. (See E.D. Pellizzari, R.L. Perritt, and C.A. Clayton, "National Human Exposure Assessment Survey: Exploratory Survey of Exposure Among Population Subgroups in EPA Region V," "*Journal of Exposure Analysis and Environmental Epidemiology,*" Vol. 9 (1999), pp. 49–55.

[23] These participants provided biological samples, such as blood and urine. Larger participant groups in the study areas provided environmental and food monitoring samples and responded to questionnaires. This excludes a related but separate study done in Minnesota reviewing pesticide exposures that was not one of the three formal pilot surveys.

[24] Determining the distribution of chemical exposure among a non-occupationally-exposed population establishes a "reference range" that shows what can be considered background exposure and what can be considered high. With reference range information, officials concerned about exposures of groups can compare the groups' exposures to those of the general population and determine whether public health action is warranted to prevent or reduce high levels of exposure.

[25] ATSDR conducts exposure investigations when (1) people have likely been exposed to a contaminant, (2) more information is needed on the exposure, (3) an exposure investigation will provide that information, and (4) that investigation will affect public health decisions.

[26] In its report, panel members suggested many improvements to ATSDR's exposure investigations, including creating a technical planning group to review emerging and innovative technologies and establishing a national clearinghouse of collected data. ATSDR officials indicated that they had not been able to act on some of the panel's suggestions because of limited staff and resources and other barriers to collecting data, such as the lack of laboratory methods for testing chemicals of interest ATSDR has nine staff to conduct exposure assessments for sites across the nation and can only respond to requests from communities or State or local officials for assistance rather than conducting such assessments as part of every new investigation.

than 1,300 Superfund sites. At least 34 of these investigations detected contaminants in people and 16 found elevated levels.

Other federally conducted efforts designed to monitor or collect data on the exposures of populations within selected communities or geographic regions have also been infrequent.[27] One such regional-scale effort under way is collecting data on exposures within selected communities along the border between Texas and Mexico. Officials from Mexico and Federal and State agencies in the United States are comparing exposures of people in the border area with those in areas away from the border. Another study examined the exposures of people along the Arizona border compared to the exposures of people elsewhere in the State. This study collected environmental samples for pesticides, metals, and volatile organic chemicals. Blood and urine samples were also tested to relate the environmental measurements to the measurements in human tissues for these chemicals.

State Officials Value Human Exposure Data for Studies and Investigations but Do Not Often Include Them

Most State officials who we surveyed highly valued human exposure data. However, most could not include it in their exposure-related health studies, investigations of concerns such as disease clusters, or surveillance efforts. Almost half of the officials responding to our survey estimated that they had participated in 10 or more exposure-related studies or investigations since 1996, with about 16 percent estimating they participated in 50 or more. However, about half of the officials indicated they could seldom if ever collect exposure data through human samples in their efforts. When data were developed, officials listed five main uses: (1) environmental health epidemiologic studies, (2) surveillance of diseases or conditions with suspected environmental causes, (3) investigations of citizen concerns, (4) planned or accidental chemical releases, and (5) disease clusters (see table 3).[28] State officials we spoke with noted that human exposure data are often the most valid and persuasive evidence available to demonstrate whether, and to what extent, exposure has occurred or changed over time. In highly charged situations, where community trust has eroded, such data may be the only evidence acceptable to area residents.

Table 3.—Examples of How State Officials Use Human Exposure Data

Purpose	Example
Environmental health epidemiologic studies.	Using blood and urine samples from people who ate sport fish and were concerned about undue exposure to dioxins, pesticides, and other chemicals, health officials determined these people had exposure to some chemicals from 2 to 10 times higher than levels in a reference population. Based on these results, officials will focus a larger health effects study on exposure to those chemicals.
Surveillance of diseases or conditions with suspected environmental causes.	Virtually all States collect information on blood lead levels in children to monitor and prevent lead poisoning. Some also monitor exposure to pesticides and other chemicals such as mercury and arsenic.
Investigation of citizen concerns	Health officials used human tissue measurements and citizens' reports of illnesses to demonstrate that the combined effect of chemicals released into the environment posed a health hazard severe enough to warrant evacuating nearby residents. State and Federal officials subsequently closed a manufacturing plant because of the harmful health effects of its chemical releases.
Investigation of planned or accidental chemical releases.	Officials in nine States asked CDC to test tissue samples from almost 17,000 individuals thought to have been exposed to methyl parathion, a deadly pesticide. CDC's ability to measure the pesticide in human tissue and compare exposures across States was critical to identifying individuals with high exposures and houses most in need of clean-up. Because relocating residents and removing the pesticide from homes cost up to $250 000 per household, the exposure data helped officials avoid spending limited funds on houses that did not pose a health risk to the people living in them. One State official said the exposure results reduced the number of houses needing pesticide removal from hundreds to fewer than 10.

[27] Federal agencies also might fund academic research that is designed to identify communities of concern. Assessing the extent that federally supported academic research included or focused on human exposure data to identify at-risk population was beyond the scope of our review.

[28] Since most States conduct surveillance for lead exposure, we asked officials to not include these efforts in their responses. See app. III for a copy of our survey.

Table 3.—Examples of How State Officials Use Human Exposure Data—Continued

Purpose	Example
Investigation of disease clusters	State health officials reviewed data on individual cases of cancer in one community and for the entire State. When available data on known risk factors did not account for the increased incidence of breast cancer, officials began a more detailed study that included human tissue analysis. Blood samples were obtained from women before and after treatment began and from women in a control group. Results will be compared to reference range data developed by CDC. One goal of such studies is to help identify environmental factors that contribute to breast cancer risk.

While mercury, arsenic, and pesticides were most often reported as being studied in human samples, some State officials reported using human exposure data for chemicals that CDC has since 1991 developed methods to measure. For example, about 15 percent of officials conducted studies of human exposure to volatile organic compounds, and almost 30 percent reported studies of exposure to PCBs using data from tissue analysis.

Regardless of whether State officials had collected or used human exposure data in the past 4 years, about 90 percent of those officials responding to our survey said human exposure data from tissue samples was extremely or very important for addressing environmental health concerns. Despite the perceived value of such data, almost two-thirds of officials said they could include human exposure data in fewer than half of the exposure-related studies, investigations, and surveillance efforts where they considered it important. More than one-third said they seldom could include such data.

Several State health and laboratory officials whom we interviewed expressed frustration at the missed opportunities for collecting biological samples as part of their studies and investigations for reasons such as limited laboratory capacity. For example, health officials in one State could not examine the role played by methyl t-butyl ether (MTBE)—an additive designed to promote more efficient burning of gasoline—in a major respiratory disease outbreak because State staff lacked the expertise and CDC staff lacked the time to conduct the needed tests. In 1995, after MTBE was added to gasoline and thousands of citizens reported becoming ill, State officials wanted to measure MTBE or its by-products in blood from samples of individuals with and without symptoms to determine whether MTBE exposure might be the cause or a contributing factor. Objective measures of individual exposure might have allowed public health officials to conclusively demonstrate or rule out a link between the outbreak and exposure, something that was not possible with environmental data and epidemiologic surveys. The chemicals officials most often cited as wanting to study using human exposure data, but could not, were pesticides and volatile organic compounds.

SIGNIFICANT INFORMATION AND INFRASTRUCTURE GAPS POINT TO NEED FOR STRATEGIC PLANNING AND COORDINATION

As part of our survey and interviews, we asked public health experts and State and Federal officials to identify barriers they considered significant to structure their efforts to collect and use human exposure data. Officials cited two primary barriers: the lack of laboratory capacity or methods to analyze tissue samples and the lack of information to help set exposure test results in context. Addressing these barriers takes time and resources. In that regard, we identified a third barrier to more effective use of existing resources: HHS and EPA lack a long-term strategic plan to address infrastructure and science barriers, coordinate efforts to meet Federal and State needs, and address the many questions about how to set priorities given their limited resources.

Laboratory Capacity and Methods to Measure More Chemicals Needed

State officials frequently said insufficient laboratory capacity in their States and at the Federal level hindered their ability to obtain human exposure data in cases where they thought such data were important. Over half of the officials said their States lacked sufficient numbers of trained laboratory staff, sufficient laboratory capacity to analyze samples, or sufficient laboratory equipment. Many officials attribute such capacity limitations to funding constraints because tissue analyses can be time-consuming and expensive to perform. For example, according to a CDC official, each test to measure dioxins in a sample requires (1) a laboratory free from chemicals that could compromise test results, (2) specialized equipment that costs about $500,000, and (3) highly trained and experienced staff to complete. Officials

of a professional organization representing public health laboratories told us that, although many State laboratories perceive they have a role in conducting tests to detect toxic substances in humans, very few currently have such capacity.[29]

State and Federal officials we interviewed told us that because few State laboratories have the necessary equipment and expertise, they often rely on CDC's environmental health laboratory staff to analyze tissue samples. Given the specialized laboratory requirements, CDC's environmental health laboratory is generally considered the best-suited to analyze tissue samples for a range of chemicals and has, in fact, developed many of the methods to do so, according to Federal and State officials. CDC's laboratory performs measurements for most Federal and many State efforts to gather human exposure data. Many officials said CDC's laboratory capacity is essential to their efforts and needs to expand to meet growing needs. A few State officials said CDC's laboratory consistently returned test results when people's lives were at risk but was less able to help States assess health risks more generally. An official in one State said that, while CDC's assistance is invaluable, the State's laboratory capacity allowed public health officials to obtain human exposure data and investigate citizen's concerns more frequently than they could if they had to rely soley on CDC's laboratory capacity.

Another significant issue is the lack of analytical laboratory methods to measure chemicals of concern. Despite advances over the past 2 decades in analytic chemistry and molecular biology, laboratory methods have not been developed to measure about 88 percent of the 1,456 chemicals in our review, according to information provided by CDC and EPA officials. Although laboratory staff at CDC have quickly applied scientific and technological advances to develop new and more efficient laboratory methods, they are concerned about the lack of methods to test a single human sample for several related toxics. For example, a method exists to measure arsenic in blood but not to measure arsenic and other heavy metals at the same time. Such methods make more efficient use of the samples that are gathered and greatly reduce the time and money needed to test large numbers of samples. While CDC's laboratory continuously develops new chemical testing methods, current resources limit the number to about 10 annually.

Even when analytical methods exist, efforts to gather human exposure data are sometimes limited by problems with the methods used to gather the samples. This is especially true for young children, a group thought to be particularly susceptible to harmful effects from exposure. In some cases, existing laboratory methods require sample volumes that can only be obtained through invasive techniques. That is, blood samples must be obtained by puncturing a vein rather than by pricking a finger. Many people will not allow their children to participate in studies that require such techniques. Similarly, urine samples can be difficult to obtain from children who wear diapers. For example, substances in the diapers can compromise test results.

Information Needed to Interpret Human Exposure Measurements

To help interpret the results of laboratory analysis and determine what actions, if any, are needed to protect the public's health, State and Federal officials cited the need for two types of context-setting data: comparative (or reference range) information that shows exposure levels among the general population and research that links exposure to adverse health effects. At the State level, where many of the specific actions regarding at-risk situations are taken, almost three-fourths of responding officials cited the lack of such information as a problem.

State officials said that reference range data, when available, allowed them to determine whether exposures are sufficiently high to merit action to reduce or prevent further exposure. For example, in one State, public health officials, with help from CDC, responded to citizens' reports of foul odors from leaking tanks at a waste cleanup site by gathering and analyzing blood samples from those living nearby. CDC's analysis of the blood samples showed that residents near the site had exposure levels at the high end of a CDC-developed reference range. State and Federal officials ordered the contractor to move the cleanup operations to another location. Over 60 percent of State officials responding to our survey said the lack of reference range data prevented them from using human exposure data in their work. State officials said the problem for research about adverse health effects was similar.

[29] This organization actively supports expanding State and local laboratory capacity to participate in a human biomonitoring program to provide human exposure data that would enhance the effectiveness of environmental policy and regulatory decisions. In addition this group helped States apply for the four grants CDC offered to increase State and local laboratory capacity to detect in human fluids and issues chemicals that could be used in a terrorist attack. Illustrating their interest in developing such laboratory capacity, 31 State and 2 local health departments applied for the four grants.

Much of the data linking exposure to health effects concerns high-level occupational exposures or higher doses administered to laboratory animals. Consequently, translating the results of such research to lower-level exposures of people and determining how best to advise people about potential effects is problematic.

Federal health officials and researchers also cited a need for both types of information in their investigations, particularly for federally supported work in specific geographic areas. ATSDR officials said the lack of reference ranges was a particular reason they could not generate human exposure data more often in public health assessments and exposure investigations. When data allow officials to put exposure into context, concerns can be investigated and addressed. For example, in one community, where citizens were concerned about exposure to dioxins from nearby chemical manufacturing plants, ATSDR officials had CDC's laboratory analyze blood samples and found that some residents had levels of several dioxins above the highest levels in a CDC-ATSDR-developed reference range. In response, ATSDR helped residents obtain assistance from medical professionals expert in dioxins and, working with State and Federal environmental agencies, began environmental testing to locate the exposure source.

Stronger Interagency Efforts Needed for Strategic Planning and Coordination

The barriers outlined above present daunting challenges to State and Federal agencies. The number of chemicals that remain to be investigated and the kinds of information needed are substantial, the research is often expensive, and progress is often slow. At the same time, the level of resources available for dealing with the issue is limited, and responsibilities are fragmented among many State and Federal agencies. Many studies have pointed to the need for better coordination. While HHS and EPA efforts have been coordinated through, for example, participation on advisory committees and the use of CDC's laboratory for performing the actual measurements, such coordination falls short of what is needed for long term planning. This need is illustrated by the growing convergence of interest in the planned expansions of NHANES and NHEXAS. To ensure as much progress as possible with available resources, HHS and EPA need a strategic planning effort that reflects a clear set of priorities, a framework for coordinating data collection and reporting efforts, and a tie to performance goals.

Agreement About Need for Better Planning and Coordination of Efforts Is Widespread

In 1991, NRC reported that "although a successful monitoring program must be highly relevant to regulatory needs, it could and should serve a wide range of client programs and must not be dominated by any one of them." NRC reported that the approaches of EPA, CDC, and ATSDR are each important in the identification and control of environmental hazards to human health and that coordination among the programs would enhance Federal monitoring efforts and benefit researchers, health professionals, and the public.[30]

Officials and experts agree that interagency interaction is needed to take advantage of all approaches and information available to develop the most cost-effective, least burdensome approach for collecting needed exposure data. Toward this end, HHS agencies and EPA have at various times attempted to collaborate in their respective exposure monitoring efforts. For example, EPA solicited broad interagency input into the design of NHEXAS and established interagency agreements with CDC and others to assist in performing laboratory measurements, quality control, and other support functions. Also through interagency agreements, CDC has broadened the exposure monitoring component of NHANES to incorporate the needs of EPA researchers.

Outside reviews and involved researchers and officials indicate that even with recent efforts, coordination has fallen short in ensuring adequate interaction and linkages between agencies. For example, EPA's scientific advisers reviewed the NHEXAS pilot surveys and concluded that, while NHEXAS was an excellent project and highly relevant for providing needed information, a strategic plan was needed for follow-up studies. They also urged that EPA link NHEXAS exposure data with biological data from NHANES, where possible, and develop a more collaborative process for gathering input for chemical selection. Attendees at a September 1999 NIEHS conference on the Role of Human Exposure Assessment in the Prevention of Environmental Disease also called for a coordinated interagency effort in assess-

[30] While NRC found EPA in the best position to house a human exposure monitoring program, it also found that the ambivalence within EPA about the National Human Monitoring program's future indicated that the match of program goals, potential benefits, and EPA mandates was not perfect.

ing human exposure.[31] One theme and recommendation from the discussions was the need to bridge scientific disciplines and agency missions to address knowledge gaps in assessing human exposure.

State officials and others have also indicated that better linkages and partnering are needed between Federal, State, and local agencies. For example, an official of the Association of Public Health Laboratories told us that one way to improve States' involvement in a national exposure monitoring program would be to further their capability to assess levels of toxic chemicals in their own populations relative to national levels. This would require, in this official's view, the transfer of new monitoring technology to State public health laboratories, along with the resources necessary to support that technology. Improved capacity at the State level would allow Federal laboratories to concentrate on developing more and faster analytical methods for measuring chemicals in tissues and on responding to crisis situations. Other experts have also called for better linkages between Federal efforts and communities and community concerns. For example, the NHEXAS reviewers recommended that EPA improve communication between NHEXAS investigators and State and local health officials. Another theme of the conference on human exposure assessment was that efforts to assess human exposure be in line with public health goals and community concerns.

Individual Priorities Contribute to Difficulties in Coordinating Efforts

The challenges Federal and State agencies face in setting priorities for which chemicals to assess in their individual programs likely contribute to the difficulties they have in collaborating with one another. The expense of conducting exposure measurements in ongoing surveys—especially for the number of samples required to establish national or regional trends and levels—necessitates that priorities be set. However, agreeing on priorities—or even agreeing on the process for setting priorities—is challenging and resource-intensive. For example, to identify chemicals to measure in NHEXAS, EPA undertook an extensive selection process, soliciting input from regional and program offices.[32] EPA's scientific advisers, while supportive of the program, cited the criteria for selecting target chemicals as a weakness. NHANES is even less formal in this regard, with no documented priority-setting process for chemicals to be measured. Chemicals measured are largely determined by CDC's laboratory scientists based on such factors as the availability of analytical methods for measuring the chemical and the laboratory's capacity to perform the measurements.[33] According to a CDC official, CDC's limited staff and laboratory resources cannot develop the administrative infrastructure to establish a scientific review process for selecting priority chemicals.

Another challenge in setting priorities, according to some officials, is the appropriate balance between gathering exposure information on chemicals about which little is known and gathering information on those already considered to be toxic. NHANES and NHEXAS, for example, focus largely on chemicals that are considered to be toxic at some level. By contrast, the National Toxicology Program's Human Exposure Initiative is intended to help set priorities for chemical toxicological testing and might gather baseline information on chemicals and chemical mixtures occurring in the population that are not necessarily already known as harmful.

Officials we interviewed raised many other concerns that would need to be addressed when trying to coordinate efforts among multiple Federal and State agencies and programs:

- For what specific purpose(s) will these data be collected?
- What chemicals should be measured, in what order, how frequently, and in what specific tissues?[34]

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[31] The NIEHS-supported conference addressed many opportunities and challenges in exposure assessment research including exposure-analysis methodology, exposure-disease relationships, regulatory and legislative issues, gene-environment interactions, disease prevention and intervention and some current Federal initiatives related to exposure assessment. One area of discussion was the need for and limitations of biological measures of exposure.

[32] Because of its emphasis on evaluating total human exposure, NHEXAS emphasized those chemicals that can be measured In multiple environmental media (for example in air, water, and food) as well as human tissues.

[33] CDC's laboratory officials indicated that their choice of chemicals is determined by the availability of high-quality analytical methods with adequate throughput, whether the chemical is a known or suspected cause of health problems, whether the chemical is on EPA and ATSDR priority lists, the number of persons likely exposed, and the availability of funding from collaborators.

[34] Several officials pointed to the importance of developing a breast milk monitoring program. Many environmental agents are fat soluble and are released into breast milk at significant con-

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• What chemicals should be measured concurrently with or only through personal environmental measurements?

• What is the best way to identify populations that might be at higher risk of exposure?

• What chemicals should be monitored in humans nationally, versus regionally or locally?[35]

• How can exposure data be coupled with our increasing knowledge about the effect genetic factors have on risk from exposure to improve the understanding about an individual's risk from chemical contaminants?

• What role should State agencies have in conducting human exposure measurements and in planning Federal efforts?

The fragmentation of responsibilities and efforts for assessing human exposure reflect larger issues in the fragmentation of responsibility for environmental health. For over a decade, a number of studies have pointed to the need for improved coordination between regulatory and health agencies (see table 4).

Table 4.—Examples of Reports Calling for Coordination in Environmental Health

Report	Description
Environmental Health Data Needs: An Action Plan for Federal Public Health Agencies (Public Health Foundation, 1997).	Called for the Federal Government to facilitate stronger ties between environmental protection and public health agencies, perhaps by strengthening organizational links and coordinating funding for Federal (EPA and HHS) programs. Also indicated that priority environmental health information needs included more complete exposure data, including laboratory data such as biological measurements.
Burke, Shalauta, and Tran, The Environmental Web: Impact of Federal Statutes on State Environmental Health and Protection (Public Health Service, Jan. 1995).	Found that progress in understanding the relationship between human health and the environment will require, among other actions, improved cooperation between the many health and environmental agendas at the Federal, State, and local levels.
Researching Health Risks (Office of Technology Assessment, 1993).	Reported that although agendas are expanding their research efforts, few incentives exist for them to collaborate, and the lack of collaboration can only hinder progress in applying newly developed techniques and knowledge to understanding the potential links between exposure and adverse health effects.
The Potential for Linking Environmental and Health Data (National Governors' Association, 1990).	Reported that linkage of environmental and health data to investigate possible connections between exposure and adverse health effects cannot occur without interagency communication and cooperation, which rarely evolves naturally.
The Future of Public Health (Institute of Medicine, 1988).	Found that separating environmental health from public health programs impeded desirable coordination and could limit the depth of analyses given to the health implications of environmental hazards.

Potential for Convergence of Effort Is Increasing

The importance of planning and coordination is magnified by the possible overlap in current plans to expand human exposure monitoring efforts. This potential can be seen in HHS' and EPA's plans for NHANES and proposed expansions of the NHEXAS pilots. Although nearly two-thirds of the chemicals measured in the NHEXAS pilot surveys are currently measured or planned for NHANES, the two efforts have taken differing approaches in the past to monitoring the population's

centrations. Examples include dioxins and PCBs. According to NIEHS researchers, 6 months of nursing could result in dioxin or PCB concentrations in infants which are 10 times higher than in the mother. Breast milk monitoring programs operate in several European countries including Sweden, Germany, and the Netherlands.

[35] EPA's scientific advisers' review of the NHEXAS pilot surveys illustrates some of the tradeoffs in determining the appropriate balance between large population surveys and more targeted follow-up surveys. The advisers reported that population studies are the only means for collecting baseline information for such uses as trend analysis. NHANES is an example of such a probability study. On the other hand, more targeted special studies tend to assess high-end exposure groups more precisely. Additionally, the review illustrated how total exposure data may be unnecessary to collect for chemicals at a national level, depending on the chemical. The advisers pointed out that targeted special studies can be used to identify sources and factors associated with high-end exposures. While identification of major sources, media and pathways for populations experiencing high exposures are essential to reduce unacceptably high risks, if the majority of the national population is exposed to pollutants at levels under health-related benchmarks, source identification for such exposures is not a priority from a health standpoint.

exposure to these chemicals.[36] The NHEXAS pilots have focused on "total" exposure, which entailed measurements in human tissues, water, air, food, dust, and other potential sources in participants' living environments, and data-gathering has focused on three selected regions of the country. Total exposure measurements can help identify those sources that most contribute to exposure—a critical part of determining how to take action to reduce or prevent exposures. However, measuring total exposure requires several types of laboratory measurements and is thus more expensive. By contrast, NHANES has focused its exposure monitoring on human biological measurements and on a sample that is generally representative of the Nation as a whole. Biological monitoring data demonstrate exposure from all sources, but determining exposure sources usually requires additional environmental measurements. Other than the few chemicals it covered, NHANES has historically been considered an awkward vehicle for including exposure monitoring—in large part because of its wide range of competing goals and lack of a primary commitment to monitoring tissues for exposures.

Changes to the 1999 NHANES, such as the following, show a greater emphasis in environmental health. These changes along with EPAs plans to expand NHEXAS suggest a convergence of the two approaches and a growing and overlapping interest among agencies in exposure measurement and monitoring.

• NHANES now has a goal of monitoring exposures. Starting with NHANES 1999, CDC formalized its commitment to monitoring trends in the nation's environmental exposures by establishing this as a Stated goal of NHANES.[37] In line with this goal, CDC's laboratory plans to issue this year a "National Exposure Report Card" using NHANES samples.[38] This goal is similar to EPA's goal as proposed for NHEXAS' follow-up survey—to document the status and trends of the national distributions of human exposure to potentially high-risk chemicals.

• NHANES will include selected environmental measurements. Starting with NHANES 1999, environmental measurements, such as contaminant levels in water and house dust, and levels measured through personal air monitors worn by participants will be included in the survey to help identify potential sources of exposure.[39]

• NHANES will be conducted continuously rather than periodically, allowing for more flexibility in the measurements it includes. According to CDC officials, the new annual sampling design will enable them to include emerging and changing priorities in the data collected through the survey and thus allow for a broader collection of data than in previous surveys, including exposure and measurements in people's personal environments.

Other planned changes to NHANES and NHEXAS also indicate a growing overlap in approaches and interests. For example, pending analysis and evaluation of its pilot surveys, EPA is proposing to expand NHEXAS beyond the regional focus of its pilot to include a nationally representative sample similar to the framework of NHANES. Also, both CDC and EPA would like to eventually include a component in NHANES and NHEXAS to monitor special populations. EPA's proposed expansion of NHEXAS would eventually include "special studies" to examine high-end exposures in more detail and with greater precision Small populations for further study would be identified through the national survey. CDC also plans to add a component to NHANES that will gather selected NHANES health and nutrition data, possibly including exposure measurements, on specific subpopulations in geo-

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[36] The follow-up to the NHEXAS pilots has not been planned, so the identity of the chemicals to be measured is not known.

[37] At this writing, NHANES' goals are to (1) estimate the number and percentage of persons in the United States and designated subgroups with selected diseases and risk factors: (2) monitor trends in the prevalence, awareness, treatment, and control of selected diseases; (3) monitor trends in risk behaviors and environmental exposures; (4) analyze risk factors for selected diseases; (5) study the relationship between diet, nutrition, and health; (6) explore emerging public health issues and new technologies; and (7) establish a national probability sample of genetic material for future genetic research. CDC official told us that the emerging focus in NHANES on environmental health issues reflects advances in technology as well as the public's increasing priority for understanding the impacts of environment on health. Part of CDC's responsibility is to report on environmental hazards and determinants of health. Section 306 of the Public Health Service Act (42 U.S. C. 242k) directs the National Center for Health Statistics, the CDC agency that conducts NHANES, to collect statistics on subjects such as the extent and nature of illness and disability of the population; environmental, social, and other health hazards; determinants of health; health resources; and utilization of health care.

[38] According to CDC laboratory officials, the first report card will provide data on exposure levels of the population to 25 chemicals that have not yet been determined. These might include selected heavy metals, indoor air pollutants, nonpersistant pesticides, and phthalates.

[39] Because of the wide range of other health and nutrition questions addressed in NHANES, environmental measurements currently included are less extensive than those included in NHEXAS because, for example, food and beverage samples are not conducted.

graphic areas of interest or among specific racial or ethnic minority populations. This effort to add a subpopulation component to NHANES was initiated in response to the needs of State health officials and others for local level data.

Funding Is Sporadic, and Funding Priorities Change

Part of the difficulty in collaborating and in planning human exposure monitoring efforts to meet longer-term needs may also arise from issues of sporadic funding and resources to support these efforts. As compared to the hundreds of millions spent on monitoring contaminants in environmental media, we estimate that less than $7 million was spent collectively by CDC (including ATSDR) and EPA on their respective human exposure efforts in 1999.[40]

Neither CDC nor EPA has provided a dedicated funding stream for their exposure measurement efforts. Funding for efforts has, to a large extent, depended on priorities established year to year. For example, funding for the exposure and other environmental components of NHANES depends to some extent on the interests of other Federal agencies and their willingness to pay for related data gathering and analysis.[41] CDC estimated it would spend about $4.7 million for laboratory measurements and laboratory staff costs in 1999 for NHANES-related exposure measurements such as lead, mercury, cotinine, heavy metals, pesticides, volatile organic compounds, and other chemical classes. Interagency agreements document the receipt of about $1.2 million from collaborators for some of those laboratory measurements. If other agencies do not pay CDC to conduct laboratory tests—with the exception of some "core" measurements, such as lead—CDC performs tests as time and laboratory resources allow. For example, although CDC initially proposed for the survey starting in 1999 to measure up to 210 chemicals in tissues of a subset of NHANES survey participants, CDC officials indicated that those chemicals could be measured only as resources allowed.[42] At the time of our review, a CDC laboratory official indicated that resources might allow them to include about 74 chemicals in 1999 and 2000.

EPA's commitment to funding NHEXAS also remains uncertain. EPA officials estimated that approximately $20 million was spent on NHEXAS from 1993 through 1999—with a decreasing amount designated to the project in 1999 and 2000. While EPA's independent scientific advisers commended the design for NHEXAS and said it could be the basis for an effective national program, they expressed concerns about the limited resources allocated to analyze the data gathered in the pilot projects.[43] At national level, EPA has dedicated approximately three full-time positions to evaluate the data from the NHEXAS pilots and design future expansions.

Better Linkages to Program Goals and Performance Monitoring Needed

The Government Performance and Results Act of 1993 (Results Act) provides Federal agencies a structured frameswork to coordinate efforts in crosscutting programs when agency missions overlap. The Results Act requires Federal agencies, as part of their mandated responsibilities, to prepare annual performance plans that discuss agency goals and performance measures. Past reviews have shown that EPA, HHS, and other Federal agencies have not fully used the Results Act planning process to explain how each would coordinate crosscutting efforts with other agencies. Few agency plans attempt the challenging task of discussing planned strategies for coordination and establishing complementary performance goals and common or complementary performance measures.

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[40] NIEHS–CDC interagency agreements document that NIEHS had provided about $3.3 million to CDC between fiscal years 1996 and 2000 for performing environmental exposure measurements for its Human Exposure Initiative. No funding was provided in fiscal year 1999.

[41] NHANES 1999, for example, received $15.9 million in appropriated funding and, according to CDC officials, an additional $6.8 million from collaborating institutions. Interagency agreements related to environmental measurements performed in conjunction with NHANES document the receipt of about $1.4 million from collaborators at EPA and other agencies for environmental exposure measurements. In addition to EPA's support for measurement of certain chemicals in human tissues, an estimated $125,000 was received from the Department of Housing and Urban Development for performing dust sampling and an estimated $30,000 from the Mickey Leland National Urban Air Toxics for personal measurements of volatile organic compounds. CDC laboratory officials indicated that the increase to their fiscal year 2000 funding for the environmental health laboratory has improved their ability to support needed laboratory measurements for NHANES and other efforts. This funding increased by about $5 million between fiscal years 1999 and 2000.

[42] According to CDC officials, uncertain funding may limit their ability to perform NHANES measurements for dioxins, furans, coplanercoplanar PCBs, phytoestrogens, certain heavy metals, phthalates, and polyaromatic hydrocarbons.

[43] EPA officials indicated that at the individual study level, approximately $250,000 was allocated for analyses of the NHEXAS pilot data in fiscal year 1999; EPA plans to spend approximately $170,000 in fiscal year 2000.

A major weakness of EPA's fiscal year 2000 Annual Performance Plan was the lack of sufficient detail describing crosscutting goals and activities or how EPA planned to coordinate with other Federal agencies on related strategic or performance goals.[44] For example, under its plan's "safe food" objective, EPA discusses coordinating with HHS and other agencies to reduce health risks from pesticides. However, it did not outline specific projects and strategies, responsibilities, and products that must be coordinated for EPA to accomplish its goals. Similarly, HHS' performance plan lacked details regarding how crosscutting activities and goals would be coordinated with other agencies.

In their fiscal year 2001 performance plans, EPA and CDC make limited use of human exposure data to measure or validate performance, and neither agency describes how data collection efforts relate to complementary goals of other Federal agencies. For example, EPA and CDC have the common goal of reducing childhood lead poisoning, but only CDC uses data on blood lead levels to validate progress toward this goal. Although EPA has goals that are clearly related to reducing human exposure to other toxic chemicals, the human exposure data collected by EPA and CDC have largely not been linked with or used to measure progress. Such data show potential for helping elucidate Federal progress in environmental efforts, but EPA has not yet acted to fully realize such potential. For example, NHEXAS data are used to help assess children's exposure to pesticides. However, a related goal to reduce public exposure to pesticides does not use human exposure data; instead, it relies on the number of activities to educate agricultural workers and the public. The effectiveness of these efforts could be assessed, in part, through measured reductions in actual human exposure to specific pesticides. During 1999, CDC maintained a goal to develop methods to measure toxic substances in humans and added a goal to measure and report on human exposure to toxic substances. However, neither goal discusses how CDC will coordinate with EPA and other Federal programs in meeting these goals and ensuring that newly developed methods and measured substances meet priority data needs.

Successful Models for Planning and Coordination Point to the Need for High-Level Mandate, Process for Inclusion, and Mechanism for Reporting

Program officials at HHS and EPA told us in early 2000 that they were discussing the merits of establishing a new interagency program in human exposure monitoring.[45] At the time of our review, the proposal was in early stages of discussion and officials had not clarified how a new program would consider States' information needs, differ from or relate to NHANES and the NHEXAS pilot surveys, or resolve past issues about differing agency goals and priorities.

Several experts and agency officials have pointed to successful models of interagency collaboration in environmental health issues that could help shape an HHS-EPA interagency effort. One such model is the collaboration on children's environmental health issues. In this case, Executive Order 13045, signed by the President on April 21, 1997, established a Task Force on Environmental Health Risks and Safety Risks to Children to develop and recommend Federal strategies for children's environmental health and safety. Among the elements that have been cited as contributing to success were a clear mandate to collaborate and a process to respond to the input and data needs of different stakeholders. According to involved officials, a high-level interagency work group has worked closely to address its charges. These charges include developing general policy and annual priorities; a coordinated Federal research agenda; recommendations for partnerships among Federal, State, local, and tribal governments and the private, academic, and nonprofit sectors; and identifying high-priority initiatives to advance protection of children's environmental health.[46]

A second model with a top-down mandate and a process to respond to stakeholders is NTP, established in 1978 as an HHS-wide effort to provide regulatory and research agencies needed information about potentially toxic and hazardous chemicals nationwide and to strengthen the science base in toxicology. According to officials, part of NTP's success in fostering collaboration are an inclusive executive committee and an established process for decisionmaking. The NTP Executive Committee, which provides policy oversight of NTP, includes agencies outside of HHS, such as EPA and the Consumer Product Safety Commission. The NTP Executive

[44] See Observations on the Environmental Protection Agency's Fiscal Year 2000 Performance Plan (GAO/RCED–99–237R) July 20, 1999.

[45] This effort was coordinated through the White House Office of Science and Technology Policy.

[46] Executive Order 13045 also indicates such strategies are to include proposals to enhance public outreach and communication and a statement regarding the desirability of new legislation to fulfill or promote the purposes of the order.

Committee also serves as a decisionmaking body, in that members cast votes on key issues, such as prioritization of chemicals for study and for listing in NTP's Report on Carcinogens.[47] Involved officials believe the voting requirement helps move key issues forward and provides an effective means of resolving disagreements. NTP also has an inclusive process for identifying chemicals to be considered by the Executive Committee. NTP's chemical testing nominations are solicited from sources in academia, Federal and State regulatory and health agencies, industry, and unions, as well as environmental groups and the general public.

Several officials indicated that reports on exposures in the national population to toxic chemicals are needed to help inform policymakers, researchers, and the public. Specifically, such reports can help identify serious human health risks, help officials link exposures to sources, determine appropriate interventions to help reduce these risks, and document the effectiveness of interventions in reducing exposures. Moreover, agencies could use such reports to validate or measure progress in meeting goals established under the Results Act. A key element of NTP is its biennial reports. As informational scientific and public health documents, these reports are not only used by Federal and State agencies but are considered an important medium for informing the public and policymakers on the status of substances considered likely to be carcinogenic for humans.

CONCLUSIONS

The Nation has a long way to go in measuring human exposures to potentially harmful chemicals. While Federal efforts are increasingly covering chemicals of potential concern, there are substantial gaps in current information on exposure levels, the health risks that result, and those who may be most at risk. Recent advances in laboratory technology show promise for improving the collection and analysis of some of the information needed to understand and measure human exposures. However, a more long-term and concerted effort to address infrastructure and scientific limitations in measuring exposure will be required if substantive progress is to be made. Applying and continually improving upon these advances to cover an increasing number of chemicals and issues will require both time and resources. CDC's laboratory to date has been able to meet many demands for human exposure data for Federal and State measurement and monitoring efforts. However, its capacity, given current resources, will continue to limit progress to develop new methods and include more people and chemicals in Federal and State efforts.

Federal agencies are currently planning whether and how they can expand existing programs to meet the significant needs for human exposure data. Collaboration in such planning is essential, because agencies have different capacities and skills, and separate attempts have fallen short of supporting the large efforts that are needed. So far, no clear strategy has emerged for how to carry out this major task, particularly given the growing and overlapping interests among many agencies for understanding and measuring human exposures to potentially harmful chemicals. In our view, developing such a strategy is a challenging but necessary first step.

In the meantime, State and local health officials must try to understand and communicate the risks from environmental contaminants to concerned citizens—a difficult, if not impossible, task when information is unavailable to help them interpret the risks from the exposures citizens face in their daily environments. State officials indicate they need more of the information that is collected through Federal efforts to help interpret those levels faced by citizens in their States. And to collect measurements for their studies and investigations, State officials are faced with finding laboratories that have the equipment and capacity to perform the complex measurements. Federal capacity, largely centered at CDC, cannot meet States' needs in many situations, and laboratory capacity is lacking in most States.

To help meet the gaps in environmental exposure data at all levels of government, EPA and the various HHS agencies with environmental health responsibilities need to work closely together to forge a strategic plan laying out the necessary next steps for addressing human exposure information and concerns. In addition to considering States' needs and capacities for collecting human exposure data, such a plan could:

- provide long-term structure to human exposure monitoring as an interagency effort,
- establish a mechanism for setting program priorities in line with agency goals and performance measures,

[47] The Director of NTP issues the Report on Carcinogens pursuant to a 1978 amendment, section 301 (B) (4) of the Public Health Services Act. which requires the Secretary of HHS to publish a list of all substances that are either known to be human carcinogens or may reasonably be anticipated to be human carcinogens and to which a significant number of persons residing in the United States are exposed. NTP issues a revised Report on Carcinogens every 2 years.

• clarify agency roles and minimize duplication, and
• help agencies share expertise.

Policymakers, agencies, and the public seek many types of information on exposure trends and levels in the national population as well as for groups considered potentially at risk of disproportionate exposures. Resolution is also needed on what information should be reported on national trends and levels of exposure. A strategic plan could help agencies resolve the many different informational needs to determine what exposure information should be reported and how agencies can work together to report such information.

RECOMMENDATIONS TO THE SECRETARY OF HHS AND THE ADMINISTRATOR OF EPA

We recommend that the Secretary of HHS and the Administrator of EPA develop a coordinated Federal strategy for the short- and long-term monitoring of human exposures to potentially toxic chemicals. In and the Administrator developing such a strategy, the Secretary and the Administrator should of EPA assess the need for an interagency program to collect and report data on human exposures, the extent current surveys and agency efforts can be used as part of such an effort, and the funding needs and sources to sustain a viable program for monitoring human exposures to toxic substances.

Such a strategy should:

• address individual agency needs and expertise,
• provide a framework for coordinating efforts to gather data needed to improve understanding of human exposures,
• assess needed Federal and State laboratory capacity,
• establish research priorities for laboratory methods development and a mechanism or process for setting chemical monitoring priorities,
• develop a framework for identifying at-risk populations, and
• consider States' informational needs.

We further recommend that the agencies identify common or complementary performance goals or measures to reduce, monitor, or develop methods for measuring human exposures to toxic chemicals. Such goals or measures can be a basis for structuring and supporting interagency collaborations to collect and use human exposure data.

As part of this coordinated strategy, we recommend that the Secretary of HHS and Administrator of EPA periodically publish a report on levels and trends in the national population of exposures to selected toxic substances.

AGENCY COMMENTS

We provided HHS and EPA an opportunity to comment on a draft of this report. Both agencies generally concurred with our conclusions and recommendations—that a long-term coordinated Federal strategy was needed for monitoring human exposures to potentially toxic chemicals and that such efforts could be linked through common or complementary performance goals—and indicated that they would work together to implement our recommendations. (See apps. IV and V respectively.) HHS and EPA also both stressed the importance, as discussed in our report, of expanding the scope of their efforts to monitor and measure human exposures to toxic chemicals beyond the limited number of chemicals covered today. To support such expansions, HHS noted the importance of additional resources for improving laboratory capacity and methods.

HHS and EPA provided several other comments raising points that one or both agencies consider important to monitoring human exposures to toxic chemicals. These included the need to: (1) coordinate any exposure monitoring in the general population with monitoring of occupational exposures; (2) consider adding the monitoring of breast milk in a national program; (3) depending on the chemical and the purpose for the data collection, consider measures of human exposure other than the concentration in human tissues for collection; and (4) consider the option of expanding the scope of NHANES as a means of improving data needed to identify potentially at-risk subgroups. We agree that the points raised in these comments are important and that they should be considered during development of any coordinated Federal strategy.

EPA also said that additional Federal partners, including the Departments of Defense, Transportation, and Energy should participate in developing and supporting a coordinated Federal strategy. We agree that it would be appropriate to obtain input from all involved and interested agencies. HHS and EPA also provided a number of clarifying and technical comments, which we incorporated where appropriate.

We are sending copies of this report to the Honorable Donna E. Shalala, Secretary of HHS, and the Honorable Carol M. Browner, Administrator, EPA. We are also

sending copies to Jeffrey P. Koplan, Director, CDC, and Administrator, ATSDR; Ruth Kirschstein, Acting Director; NIH; Kenneth Olden, Director, NIEHS; Richard J. Jackson, Director, National Center for Environmental Health; Edward J. Sondik, National Center for Health Statistics; Norine Noonan, Assistant Administrator for Research and Development, EPA; and other interested parties. We will make copies available to others upon request.

If you or your staff have any questions, please contact me at (202) 512–7119. Other major contributors are included in appendix VI.

JANET HEINRICH,
Associate Director, Health Financing and Public Health Issues.

APPENDIX I

OBJECTIVES, SCOPE, AND METHODOLOGY

Nine Members of the Congress asked us to study the nation's data collected to assess human exposure to potentially toxic chemicals in the environment. As agreed with our requesters, we focused our work primarily on efforts to measure chemical exposures in human tissue samples, such as blood, hair, and urine. This report discusses (1) the extent to which State and Federal agencies—specifically, HHS and EPA—collect human exposure data on potentially harmful chemicals, including data to identify at-risk populations, and (2) the main barriers hindering further progress in such efforts.

SCOPE OF OUR REVIEW

Although laboratory measurements of chemical exposure are only one part of the data collected to address environmental health concerns, they merit attention because new technology makes it increasingly easy to measure the degree to which a chemical has been absorbed into human tissues. Such measurements are often a more accurate and useful approach to assessing exposure than environmental measurements, according to public health experts.

Because Federal agencies that collect human exposure data collect these data for different purposes, we were not able to assess the overall adequacy of the nation's efforts to address environmental health concerns. Therefore, we focused our work at the Federal level on the efforts of two agencies—HHS and EPA—and the subcomponents of these agencies involved in exposure measurement and monitoring in the U.S. population:

- EPA's Office of Research and Development,
- HHS' National Center for Environmental Health (NCEH),
- HHS' National Center for Health Statistics (NCHS),
- HHS' Agency for Toxic Substances and Disease Registry (ATSDR), and
- HHS' National Institute of Environmental Health Sciences (NIEHS).

We focused our work mainly on nonoccupational environmental exposure to chemical agents known or thought to pose a health hazard by one or more of these agencies.

To gather information about activities of State officials, we surveyed environmental health officials in State public health agencies and conducted site visits to six States.

METHODOLOGY OF OUR REVIEW

To assess the extent to which the Federal agencies we reviewed have collected human exposure data, we met with key officials responsible for efforts intended to collect human exposure data at each agency. We focused on what we identified as being the most significant Federal efforts in human exposure assessment at EPA and HHS related to nonoccupational human exposure to environmental contaminants. We reviewed four major activities: EPA's National Human Exposure Assessment Survey (NHEXAS), CDC's National Health and Nutrition Examination Survey (NHANES), NIEHS' Human Exposure Initiative, and ATSDR's exposure investigation activities around hazardous waste and other sites. We also obtained information on EPA's National Human Adipose Tissue Survey (NHATS), which ended in 1992.

We also interviewed officials and obtained documentation on how these various programs were planned and organized and to assess the extent data were collected in a manner that allows the identification of at-risk subpopulations by such factors as income, race and ethnicity, age, and geographic location. We obtained relevant budget information for 1999 and reviewed related agency performance plans.

To assess barriers to progress in collecting or using human exposure data, we interviewed Federal officials involved in such efforts about past and current views on such barriers. In addition, we reviewed the general literature on human exposure to environmental chemicals and interviewed officials from organizations representing State epidemiologists, State public health laboratory directors, local public health officials, the chemical industry, environmental advocates, and public health experts.

To gather nationwide data on the views of State public health officials, we surveyed officials with environmental health responsibilities related to chemical exposure in State public health agencies. We identified 93 officials in each of the 50 States and the District of Columbia—referred to collectively as States—with assistance from the Council of State and Territorial Epidemiologists and officials in each of the 51 States.

We also conducted onsite work at EPA, CDC agencies, and NIEHS and in six States—California, Louisiana, Massachusetts, North Carolina, Oregon, and Washington. These six States were selected to represent diverse geographic areas and environmental health programs. In the six States, we interviewed State public health officials. We also interviewed officials in State environmental protection and agriculture agencies, academic and independent researchers, and representatives of community advocacy organizations.

We excluded efforts to collect human exposure data within occupational settings from the scope of our review. Similarly, we excluded federally supported academic and private sector research efforts.

Our work was conducted from March 1999 through March 2000 in accordance with generally accepted government auditing standards.

Methodology for Chemical List Analyses

To assess the extent to which human exposure data are available for chemicals of high concern to human health, we analyzed a number of chemical lists maintained by HHS and EPA agencies. We also identified chemicals measured through HHS and EPA representative surveys. Chemical data were gathered from various sources, including EPAs Offices of Pesticide Programs, Air and Radiation, Pollution Prevention and Toxics, and Research and Development; the National Toxicology Program (NTP) headquartered at NIEHS; CDC's ATSDR; and NCEH and NCHS within ATSDR. Several toxic chemical lists were identified through a review of related reports and literature on environmental exposure issues. To narrow the scope, we also contacted staff in relevant offices within these agencies and asked them to identify key lists of chemicals of concern. We consulted experts and public health laboratory officials at the Pew Commission for Environmental Health and the Association for Public Health Laboratories.

From the many available chemical lists, we judgmentally selected eight based on our assessment that each list contained chemicals thought to have a high potential for causing harm to human health and input and recommendations from experts. These eight lists, which contained more than 1,400 unique chemicals, provide a conservative number of the chemicals agency officials consider a concern for human health. To ensure that chemicals with more than one name were not included more than once, we used Chemical Abstract Service numbers, a unique identifier. These lists, whether singly or combined, do not necessarily reflect the highest priorities of the Federal Government or the agencies or programs we contacted. The lists we reviewed are described below.

- Chemicals found most often at the nation's Superfund sites: HHS' ATSDR, which conducts public health assessments or other health investigations for populations living around national priority hazardous waste sites, and EPA prepare a list, in order of priority, of hazardous substances. This list contains substances that are most commonly found at facilities on the National Priorities List (Superfund) and pose the most significant potential threat to human health due to their known or suspected toxicity and potential for human exposure.
- EPA's list of toxics of concern in air: The Congress established the original list of 188 hazardous air pollutants that EPA would regulate through the Clean Air Act. EPA periodically must revise the list to add or, when warranted, remove substances. EPA adds substances that it determines to be air pollutants that are known to cause or may reasonably be anticipated to cause adverse effects to human health or adverse environmental effects.
- Chemicals harmful because of their persistence in the environment, tendency to bioaccumulate in plant or animal tissues, and toxicity: EPA's Office of Solid Waste and Office of Pollution Prevention and Toxics created this list of persistent, bioaccumulative, and toxic (PBT) chemicals. PBT chemicals do not readily break down or decrease in potency after they are released into the environment, even if released

in quantities that are very small and legally permitted. Over time, these chemicals are likely to accumulate in soils or other environmental media, be absorbed or ingested by animals and plants, accumulate in animal and plant tissue, pass through the food chain, and potentially cause long-term human health or ecological problems.

• Priority pesticides of potential concern: We combined two lists of potentially harmful chemicals to develop this list. EPA's Office of Pesticides Programs provided a list of pesticides of concern that were classified as organophosphates; carbamates; or group B1, B2, or C carcinogens. According to a program official, these classes of pesticides are generally considered among the most potentially harmful to human health. We combined this list with the U.S. Department of Agriculture's Pesticide Data Program list of pesticides that are measured in selected commodities or foods. Pesticides monitored by the program in 1997 included insecticides, herbicides, fungicides, and growth regulators in fresh and processed fruit and vegetables, whole milk, and grains.

• Chemicals that are known or probable carcinogens: HHS' Report on Carcinogens includes substances known or reasonably thought to be cancer-causing based on evaluations of substances performed by scientists from NTP, other Federal health research and regulatory agencies, and nongovernment institutions. The list of substances in the report represents an initial step in hazard identification. Substances listed as "known to be human carcinogens" are those for which there is sufficient evidence of carcinogenicity (cancer-causing potential) in humans to indicate a causal relationship between exposure to the agent, substance, or mixture and human cancer. Substances listed as "reasonably anticipated to be human carcinogens" are those for which there is limited evidence of carcinogenicity in humans, insufficient evidence of carcinogenicity in experimental animals, or both.

• Chemicals that are considered toxic and used, manufactured, treated, transported, or released into the environment: EPA publishes the Toxics Release Inventory containing information on the release and other waste management activities of toxic chemicals by facilities that manufacture, process, or otherwise use them. This data base is made available to the public and is considered useful to citizens, businesses, and governments for purposes of working together to protect the quality of their land, air, and water and for evaluating the probability that chemical releases could impact human health in communities.

Chemicals most in need of testing required by the Toxic Substances Control Act: The Master Testing list contains those chemicals that are prioritized for safety testing based on EPA's finding that (1) a chemical may present an unreasonable risk of injury to human health or the environment and/or the chemical is produced in substantial quantities that could result in significant or substantial human or environmental exposure, (2) the available data to evaluate the chemical are inadequate, and (3) testing is needed to develop the required data.

We compared the combined list of these chemicals, totaling 1,456, and each individual list with those chemicals identified by EPA and CDC officials as measured in the NHEXAS and NHANES human exposure efforts through 2000. We excluded NHATS' and the Human Exposure Initiative's chemical lists from our analysis. NRC's 1991 review of the NHATS program raised questions about, for example, the representativeness of the results and the methods used to handle the tissue specimens. NIEHS' Human Exposure Initiative measurements were not complete at the time of our review and thus it was not known which chemicals had been or are currently being measured.

Survey Development and Distribution and Analysis

To develop survey questions, we reviewed documentation on environmental health programs prepared by HHS and EPA agencies, professional organizations representing State epidemiology and public health laboratory officials, and public health experts. We also spoke with officials and representatives from each of these groups.

We pretested our survey in person with State environmental health officials in two States and in teleconferences with officials in two additional States. We asked knowledgeable people in EPA and CDC and in the environmental and public health fields to review the survey instrument. We refined the questionnaire in response to their comments to help ensure that potential respondents could provide the information requested and that our questions were fair, relevant, answerable with readily available information, and relatively free of design flaws that could introduce bias or error into our study results. We mailed questionnaires to the 93 officials in August 1999. We sent at least one follow-up mailing and conducted telephone follow-ups to nonrespondents. We ended data collection in December 1999; had received responses from 81 officials in 48 States for a response rate of 87 percent.

In preparing for our analysis, we reviewed and edited the completed questionnaires and checked the data for consistency. We tested the validity of the respondents' answers and comments by comparing them with data we gathered through interviews with public health experts and other public health officials and with documentation obtained at Federal agencies and in case study States.

The survey and survey results are presented in appendix III.

APPENDIX II

REPORTED GAPS IN HUMAN EXPOSURE DATA AND HISTORY OF FEDERAL EFFORTS

Since the 1980's, reports reviewing environmental health data needs have recommended the broader collection of human data showing actual human exposures to chemical contaminants in the environment. Various Federal agencies have collected such human exposure data for a number of purposes; historically, these collection efforts have been limited to selected chemicals, subpopulations, and time periods.

VARIOUS REPORTS DISCUSS THE GAPS IN HUMAN DATA SHOWING MEASURED EXPOSURE TO CHEMICAL CONTAMINANTS

Data on actual levels of chemicals in humans has been a longstanding gap in the information needed to establish human health risks from exposures to environmental contaminants. While data on the concentration of chemicals in environmental media—such as air, water, and food—have historically been used to estimate human exposure to harmful chemicals, this approach to detect or define human health risks has limitations. According to the NRC, there are too many chemicals, too many sources, and too many routes of exposure to rely solely on environmental monitoring. Measurements of internal doses of exposure—actual levels of chemicals or their metabolites found in human tissues, such as blood or urine—are generally considered an accurate measure of human exposure. Such measurements can reflect exposures from all routes and that may be accumulated over time, modified by individual differences in physiology, and difficult or impossible to assess by environmental measurements (such as hand-to-mouth ingestion in young children). In 1991, NRC reported that a program of human tissue monitoring is critical to the continued improvement of understanding of exposure to toxic chemicals and recommended that such a program be given high priority for funds and other resources.[1]

Several other Federal reviews have pointed to information needs in this area. An interagency assessment of federally supported data bases conducted in the early 1990's concluded that Federal data systems generally lacked data on actual human exposures, including information about contact between the chemical and the human body (personal exposures) and the amount of the chemical absorbed (internal doses). The review also found substantial value in collecting and analyzing these data in a comprehensive and systematic manner and that the costs associated with establishing and maintaining appropriate data bases were justified.[2] A discussion of some of these reviews follow.

• HHS, NCHS, Environmental Health: A *Plan for Collecting and Coordinating Statistical and Epidemiologic Data* (Washington, DC: Government Printing Office, 1980): This report found that "acceptable ranges of physiologic measurements and normal levels of trace elements must be determined before any attempt can be made to associate health outcomes with environmental exposures. Many of these baseline data do not exist for particular populations of interest or for specific pollutants. In addition, early indicators and symptoms of disease that might be environmentally related are not dearly understood." The report identified a number of research directions to help define the association between health effects and specific environmental exposures, including the establishment of baseline data on physiological measurements of trace elements in tissue and blood for the population.

• HHS, NIEHS, *Issues and Challenges in Environmental Health* (Washington, DC: National Institutes of Environmental Sciences, 1987): This report found that due to "gaps in data systems established for monitoring and surveillance of environmental exposure, effort should be made to foster better linkage among existing systems . . . Existing data systems should be expanded to include biochemical and cellular indicators of early stages of disease. . . . The group found there is a need for more research and more systematic collection of data on the exposure of human pop-

[1] NRC, Commission on Life Sciences, Monitoring Human Tissues for Toxic Substances.

[2] See K. Sexton and others, "Estimating Human Exposures to Environmental Pollutants: Availability and Utility of Existing Data bases," "Archives of Environmental Health, Vol. 47, No. 6 (1992), pp. 398–407.

ulations to harmful substances. Reliable exposure data are necessary for assessing the probability that exposed populations will develop adverse health effects and the likelihood of success in intervening to reduce those risks."

• K. Sexton and others, "Estimating Human Exposures to Environmental Pollutants: Availability and Utility of Existing Data bases": This report found that while "the evidence suggests that existing data systems contain a substantial amount of information that is relevant to exposure estimation . . . the quality of the data is inconsistent and difficult to assess and that understanding and accessing the information is often difficult. Furthermore, these systems demonstrate a striking absence of data on actual human exposures, including a lack of information about contact between the agent and the human body (exposure) and about the amount of the agent or its metabolites that enters the body (dose)."

• NRC, *Hormonally Active Agents in the Environment:* This report found that "determining the risk of environmental hormonally active agents to humans and wildlife is difficult because exposure to these agents has not been routinely monitored. . . . Background concentrations of hormonally active agents in humans, particularly in adipose (fat) tissue and blood, and other biota need to be established. In particular, routes of exposure and the effects of diet need to be assessed to provide a framework for examining the effects of these compounds in the general population and in highly exposed subpopulations."

HISTORY OF FEDERAL EFFORTS TO COLLECT HUMAN EXPOSURE DATA

Since 1967, HHS and EPA have conducted Federal surveys to assess the U.S. population's exposures to toxic chemicals from the analysis of human tissue samples. While their efforts measured some of the same exposures and covered some of the same time periods, their goals differed and most did not include a nationally representative sample of citizens. EPA's efforts first monitored exposure to pesticides and, more recently, have attempted to link human exposure data to specific routes of exposure. CDC's periodic surveys are intended to monitor trends in the health and nutrition status of the population but, over time, have included exposures to environmental toxics as one component of the general survey. NIEHS' Human Exposure Initiative, established in the late 1990's, is intended to help the agency prioritize chemicals for further toxicology and carcinogenicity testing. Within these studies, various subgroups have been used to develop human exposure estimates, but in most cases, sampling has not been for all participant groups or random. Consequently, the results cannot be projected to the U.S. population as a whole for most chemicals. See table 5 for the timeframes and numbers of chemicals covered for major Federal efforts.

Table 5.—Number of Chemicals and Time Frames for Select Federal Efforts

Duration	No. of participants providing biological samples	No. of chemicals measured for any participations	No. of chemicals measured for all participants (ages 1 and older)
Second National Health and Nutrition Examination Survey (NHANES II):			
1976–1980	20,000 examined [a]	36	1
Third National Health and Nutrition Examination Survey (NHANES III)			
1988–1994	30,000 examined [a]	47	1
National Health and Nutrition Examination Survey, 1999 (NHANES)			
1999–ongoing	5,000 per year [b]	74 [c]	2 [d]
National Human Adipose Tissue Survey (NHATS):			
1967–1992	14,000	128	20 [e]
National Human Exposure Assessment Survey (NHEXAS) Pilot Study:			
1995–1999	460 [f]	46 [c]	6

[a] The number of participants in NHANES II and NHANES III who received physical examinations is used as a proxy for the number providing biological samples, as the latter number was not readily available.

[b] The number of persons examined in a calendar year is planned to be about 5,000.

[c] For NHANES, the list of potentially toxic chemicals covered was provided by CDC laboratory officials. For NHEXAS, the list of potentially toxic chemicals covered was provided by EPA NHEXAS officials.

[d] According to a CDC laboratory official, lead and cadmium are measured in all participants. Cotinine will also be measured in many participants—specifically, those ages 4 and older.

[e] Chemicals analyzed by NHATS varied over time. NHATS collected data on 20 pesticides between 1970 and 1981. NIEHS chemicals are not included because data were not available at the time of our review.

[f] Excludes a related but separate study done in Minnesota reviewing pesticide exposures that was not one of the three formal pilot surveys.

A description of these Federal efforts to collect human exposure data follows.

• *CDC's National Health and Nutrition Examination Surveys*: NHANES, conducted multiple times since 1960 by NCHS, is designed to provide national estimates of the health and nutrition status of the noninstitutionalized civilian population of the United States. Estimates are obtained by examining randomly selected participants in a manner that accurately reflects the demographic characteristics of the U.S. population. Participants are given comprehensive physical examinations (including tissue samples) and are interviewed on issues such as their nutritional habits, health conditions, and housing characteristics. NHANES data are used for a number of purposes. For example, in addition to monitoring changes in blood lead levels, uses of NHANES include development of national standards for blood pressure and cholesterol levels and for determining infection rates for diseases. CDC's laboratory housed at NCEH performs the measurements of chemicals in human tissues for NHANES.

• *Second National Health and Nutrition Examination Survey:* NHANES II was designed to provide national estimates of the health and nutritional status of the civilian noninstitutionalized population of the United States for persons aged 6 months to 74 years. Children, the elderly and people classified as living at or below the poverty level were oversampled in order to increase the reliability of the estimates for these groups. Measurements of pesticide residues were taken from participants who were between the ages of 12 and 74 years of age.[3] Blood lead measurements were taken from participants in all age groups in the survey.

Third National Health and Nutrition Examination Survey: NHANES III was designed to provide national estimates of health and nutritional status of the civilian noninstitutionalized population of the United States ages 2 months and older. Children ages 2 months through 5 years, blacks, Mexican-Americans, and persons ages 60 or older were oversampled to increase the reliability of the estimates for these groups. Blood lead measurements were taken from all particiapants ages 1 year or older. Cadmium measurements were taken from all participants ages 6 years or older. In addition, some participants ages 20 through 59 years had measurements taken for volatile organic compounds and pesticides. Participants volunteered for these additional measurements, so the results cannot be projected to the population as a whole. However, the results still serve as the reference ranges for these chemicals.

National Health and Nutrition Examination Survey, 1999: In 1999, NCHS changed the design of NHANES so that it will now be conducted as a continuous survey of about 5,000 participants annually. Like the previous surveys, NHANES will yield nationally representative results for the civilian noninstitutionalized population. The NHANES design will allow for oversampling to vary between years; persons aged 12 to 19, persons aged 60 and over, blacks, and Mexican-Americans are being oversampled. It will be tied to related Federal government data collections conducted on the general U.S. population, in particular, the National Health Interview Survey.[4] NCHS also plans to release results from the survey every year after the first 3 years of data collection. More than 1 year of data will be required for many estimates, particularly among detailed subgroups of the population. While lead and cadmium will be the only potentially toxic chemicals measured for all participants ages 1 and older (although cotinine, a metabolite which illustrates exposure to environmental tobacco smoke, will be measured for most age groups—those ages 4 and over), NCHS and NCEH plan to get nationally representative data for specific chemicals for persons in specific demographic groups, such as mercury measurements in women ages 16 through 49. NCHS will also measure household lead dust, drinking water contaminants, and exposure to volatile organic compounds for selected participants. In addition to conducting an annual national survey, NCHS is developing a smaller, more targeted health survey—the Defined Population Health and Nutrition Examination Survey (DP-HANES). NCHS recognizes that NHANES cannot collect information that would be directly useful at the local or State level or for small populations. DP-HANES is intended to address this issue through the use of small mobile examination centers that would visit areas of interest and examine 2,000 to 3,000 participants for each special study. DP-HANES participants would not receive the full range of tests given under NHANES; rather, the

[3] Data were not publicly available, as CDC is resolving some methodological issues associated with data collection.

[4] The sampling will be conducted on different people, but some questions asked in each survey will be the same.

DP-HANES examination would be tailored to the specific needs of the population under study.

• *EPA's National Human Adipose Tissue Survey:* NHATS was intended to be a continuously operating survey that would collect, store, and analyze samples of autopsy and surgical specimens of human adipose tissue from major metropolitan areas of the country. It was established by HHS in 1967 and was transferred to EPA in 1970. During its existence, NHATS data documented the widespread and significant prevalence of pesticide exposures in the general population. NHATS data also showed that reduced use of polychlorinated biphenyls (PCB) and DDT and dieldrin (common insecticides) resulted in lower tissue concentrations of these compounds. A trend analysis for 1970 through 1981 of NHATS data showed a dramatic decline in PCB concentrations after the regulation of PCBs in 1976. During the 1980's, problems with NHATS' survey design, management, and goals were compounded by insufficient financial support and caused the usefulness and quality of NHATS to deteriorate. In 1991, NRC conducted a study to review and evaluate the effectiveness and potential applications of NHATS.[5] The study concluded that a more comprehensive national program of human tissue monitoring was a critical need for understanding human exposures to environmental toxics. In addition, EPA needed a human tissue monitoring program in order to evaluate the need and effectiveness of EPA's regulatory programs. The study recommended that NHATS be completely redesigned to provide more useful data based on probability samples of the whole U.S. population and that funding be increased to permit the program to fulfill its mission. EPA ended the NHATS in 1992 and replaced it with the NHEXAS pilot surveys.

• EPA's *National Human Exposure Assessment Survey Pilot Surveys:* The NHEXAS pilot surveys were designed to obtain knowledge on the multiple pathways and media population distribution of exposures to several classes of chemicals and to test the feasibility of conducting a national survey to provide estimates on the status of human exposure to potentially high-risk chemicals. NHEXAS was also designed to measure "total exposure"—the levels of chemicals participants take in through the air they breathe; the food, drinking water, and other beverages they consume; and in the soil and dust around their homes. Measurements have also been made of chemicals in biological samples (such as blood and urine) provided by some participants. Participants completed questionnaires to help identify possible sources of exposure to chemicals. As designed, NHEXAS has three phases. Phase I is intended to develop and validate NHEXAS methods, phase II is designed to obtain nationally representative exposure data in a manner similar to that used by NHANES to get health data, and phase III is designed to follow up on information developed from phase II and will study selected subpopulations. EPA conducted NHEXAS phase I (pilot) surveys in Arizona, Maryland, and EPA's region 5 (Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin). About 460 participants in the pilot surveys provided biological samples; examinations measured a variety of chemicals, such as volatile organic compounds, heavy metals, and pesticides. Human tissue measurements were performed under interagency agreement by CDC's environmental health laboratory. EPA has completed most of the fieldwork for the NHEXAS phase I surveys and is now analyzing the results. Based on these results, EPA will finalize the scope and methods for NHEXAS phases II and III.

ATSDR's Exposure Investigations: As part of its health assessment process or in response to requests, ATSDR may conduct limited biological monitoring at hazardous waste sites or other locations through a process called exposure investigations. In response to the recognition that the conclusions drawn from indirect methods of measuring exposures were often not accurate and not reliable for assessing potential health impacts and the need for more direct measures of exposures, ATSDR formally established an exposure investigation unit within its Division of Health Assessments and Consultation. The Exposure Investigation Section was established in 1995 and is comprised of nine staff members who respond to requests to conduct exposure investigations around hazardous waste sites. These investigations involve gathering biological samples, conducting personal monitoring for site-related contaminants and their byproducts, and analyzing environmental data using computational tools.

In 1996, ATSDR convened an expert review panel to comment on ATSDR's exposure investigation program, including whether ATSDR was on the right track in providing exposure information to improve public health decisionmaking intended to address environmental releases from hazardous waste sites. The panelists endorsed many aspects of ATSDR's investigative process, including the following:

[5] NRC, Commission on Life Sciences, Monitoring Human Tissues for Toxic Substances.

• Conducting exposure investigations prior to preparing public health assessments, which makes agency responsibilities easier because information is provided that enables Federal agencies to take action and respond to community concerns in a timely manner.

• Considering exposure determinations to be as important as obtaining environmental monitoring results.

• Emphasizing the human element of exposure investigations, which illustrates that the Federal Government responds to community concerns.

The panel also made several suggested improvements to the process, including establishing a national clearinghouse of exposure investigation data and results and developing site criteria and a protocol for identifying who will decide onsites to target for exposure investigation.

ATSDR's exposure investigations have been valuable but limited in scope. ATSDR used biological monitoring in conducting 47 exposure investigations between 1995 and July 1999. Of these investigations, 17 were done in support of the 460 health assessments done at that time. Unlike NHANES and the NHEXAS pilot surveys, exposure investigations usually have a small number of participants (less than 100) who volunteer to participate in the study. While the exposure investigations are not intended to be used for generalizations about larger populations, the studies have proven very useful in ATSDR's community outreach and intervention activities.

• *NIEHS' Human Exposure Initiative:* In 1996, this initiative, a collaboration between NIEHS and CDC, was started to improve understanding of human exposures to hormonally active agents—also called "environmental endocrine disrupters"—for the national population. CDC's environmental health laboratory under an interagency agreement is developing methods for and measuring up to 80 chemicals thought to be hormonally active agents in blood, urine, or both. Human tissue samples used for these measurements are largely obtained from the ongoing sampling of the general population under NHANES and total about 200 in number.

In 1999, NIEHS and NTP officials proposed to expand the initial collaboration between NEHS and CDC by quantifying human internal exposures to selected chemicals that are released into the environment and workplace. NTP officials indicated this information would benefit public health and priority-setting in a number of ways. First, it would strengthen the scientific foundation for risk assessments by allowing (1) the development of more credible relationships between exposure and response in people thereby improving cross-species extrapolation, (2) the development of biologically based dose-response models, and (3) the identification of sensitive subpopulations and for estimates of risk based on "margin of exposure." Second, it would provide the kind of information necessary for deciding which chemicals should be studied with the limited resources available for toxicological testing. For example, there are 85,000 chemicals in commerce today, and NTP can provide toxicological evaluations on 10 to 20 per year. Third, the information could be used to identify and help focus research on those mixtures of chemicals that are actually present in people's bodies. Fourth, the types and amount of chemicals in children and other potentially sensitive subpopulations would be identified. Determinations of whether additional safety factors need to be applied to children must rest in part upon comparative exposure analyses between children and adults. Fifth, this initiative, taken together with the environmental genome initiative, will provide the science base essential for meaningful studies on gene and environment interactions, particularly for strengthening the evaluation of epidemiology studies. Finally, efficacy of public health policies aimed at reducing human exposure to chemical agents could be evaluated in a more meaningful way if human exposure data were available over time, including remediation around Superfund sites and efforts to achieve environmental equity.

Survey of State Environmental Health Officials and Results

U.S. General Accounting Office
Survey of State Environmental Health Officials and Results

Introduction

At the request of members of Congress, the U.S. General Accounting Office is conducting a study on the use of and need for measurements in human tissue of exposure to chemicals in federal and state environmental health programs. In view of growing concerns about possible health effects from environmental chemicals, human exposure data can be very useful to state and federal officials in their efforts to protect citizens.

As part of our study, we are contacting state environmental health officials in all 50 states plus the District of Columbia. We are seeking information on the extent to which state officials use and need human exposure data and general information on environmental health concerns. The questions below should take about 20 minutes to complete. Most can be answered quickly by checking applicable answers.

Instructions

We realize that human exposure data encompass a range of measures, including chemical concentrations in media such as personal air, household dust and food as well as data from questionnaires. **Our study pertains only to chemical concentrations or other markers of exposure detected in human tissue.** For our study, please use the following guidelines:

- Human exposure data are the direct measurements of chemical concentrations or other markers of exposure found in human biological samples, such as blood, hair, urine, or fat. Health officials can use information derived from the data to assess the exposure of residents near hazardous waste sites or chemical spills and conduct surveillance of conditions such as pesticide exposure. **In this survey, we use the term human exposure data to include both the direct measurements and the information, such as reference ranges of exposure, derived from those measurements.**

- Because each state conducts surveillance for lead exposure using measurements of lead concentration in blood, we want to know about the use of human exposure data for studies, investigations and surveillance of **exposure to substances other than lead.**

Please answer the questions below based on your own experience with the human exposure and health studies you participate in, including serving as an advisor. Copies of the survey may also have been provided to other officials in your state. Please provide your name and title, program, and telephone number so that we may consult with you if necessary.

Name and Title _____
Program and Agency_____
Telephone number (____)_____Email_____

Responses from all the states will be incorporated into our final report and a copy will be sent to you once it is issued. If you have questions about this survey, please contact Cheryl Williams at (503) 235-8451. Please return the completed copy at your earliest convenience, or no later than <date>, to

Cheryl Williams
U.S. General Accounting Office
1500 N.E. Irving Street, #414
Portland, Oregon 97232
Fax: 503/235-8492 E-mail: williamsc.sro@gao.gov

Thank you for taking the time to answer these questions.

81 state officials returned the questionnaire; however, some did not answer all the questions. The "N" for each question is the number of officials who answered that question.

Use of Currently Available Human Exposure Data[1] for Substances Other than Lead

1. State officials and others can use human exposure data collected by federal agencies for studies, investigations, surveillance or other health or policy analyses. Federal agencies, including the Centers for Disease Control and Prevention and the Environmental Protection Agency, collect and analyze human biological samples in efforts such as the National Health and Nutrition Examination Surveys (NHANES) and National Human Exposure Assessment Survey (NHEXAS). Since January 1996, have you used human exposure data collected by federal agencies for any study, investigation or surveillance you participated in?

   (N=81) *(check one)*

   48 Yes (specify source _____)
   33 No

2. To address environmental health concerns **other than lead exposure** in your state, how important is the federally compiled human exposure data you have used in studies, investigations, or surveillance you participate in?

   (N=77) *(check one)*

   26 Extremely important
   25 Very important
   15 Somewhat important
   11 Of little or no importance

3. State health officials may also gather human tissue samples, either directly or by request, as part of their studies or investigations. Since January 1996, have you gathered human tissue samples as part of any study, investigation or surveillance you participated in?

   (N= 80) *(check one)*

   54 Yes
   26 No

4. To address environmental health concerns **other than lead exposure** in your state, how important is the human exposure data you have gathered, either directly or by request, for studies, investigations, or surveillance you participate in?

   (N=76) *(check one)*

   33 Extremely important
   29 Very important
   7 Somewhat important
   7 Of little or no importance

[1]In this survey, we use the term human exposure data to include both direct measurements of chemical concentration in human tissue and information derived from those measurements. Exposure information includes such things as reference ranges of exposures in the general population; the distribution of exposures in a particular subpopulation, such as ethnic minorities or children; and the relative contribution to total exposure from various exposure routes, such as inhalation or ingestion.

5. Listed below are purposes for which state health officials may use human exposure data. Indicate below any purposes for which you have found human exposure data important in your work.

(N=77) *(check all that apply)*

- 48 Surveillance of diseases or conditions, other than lead exposure, that may have environmental causes
- 41 Investigation of disease clusters, including those reported by citizens
- 42 Investigation of planned or accidental chemical releases, including those in occupational settings
- 46 Investigation of citizen concerns about other perceived sources of contamination
- 28 Assessment of exposures in the state's general population
- 39 Assessment of exposures of one or more subpopulations that might be more susceptible to exposure for age, economic, or other reasons
- 53 Epidemiological studies of environmental health concerns
- 33 Epidemiological studies of occupational health concerns
- 31 Research on the relationship between human exposure and disease
- 6 Other purposes (please specify _____)

6. Consider all the exposure-related health studies, investigations of concerns such as accidental chemical releases or disease clusters, and surveillance efforts in which you participate, including as an advisor or reviewer. Estimate how many such studies, investigations, and surveillance efforts you have participated in since January 1996.

(N=81) *(check one)*

- 41 Fewer than 10
- 19 10 – 25
- 8 25 – 50
- 6 50 – 100
- 7 more than 100

7. Of the studies, investigations, or surveillance efforts you have participated in since January 1996, how often was human exposure data from tissue samples included?

(N=81) *(check one)*

- 38 Seldom, if ever
- 32 Less than half of the times
- 5 About half of the times
- 0 Over half of the times
- 6 Always or almost always

8. Of the exposure-related work you have participated in since January 1996, list below up to 5 chemicals for which data on concentration levels were obtained from analyzing human tissue samples. Please include chemicals that, in your opinion, might pose a significant health risk to residents or communities in your state.

(N=65) *(list up to 5 chemicals)* _____

Environmental Health Concerns and Human Exposure Data Generally

9. In addition to the health agency, various agencies or academic organizations in each state may study the human health effects of environmental exposures and may use human exposure data in these efforts. They may also collaborate with the state health agency in health-related efforts. Indicate below whether any other agencies or academic organizations in your state might use human exposure data and whether you have collaborated in any of these efforts since January 1996.

Indicate in

Part A: Whether the agency or organization in your state has used human exposure data in health studies, investigation or surveillance.

Part B: If you answered "yes" in Part A, indicate whether your office has collaborated with the agency in any health studies that used human exposure data since January 1996.

		Part A Used human exposure data in health studies *Check one*				Part B You collaborated in studies that used human exposure data since January 1996 *Check one*		
		Yes	No	Don't Know		Yes	No	Don't Know
Agency that may be separate from the state health agency								
1. Environmental Quality or Environmental Protection (environmental regulatory oversight)	(N=74)	34	15	25	If yes->	28	5	1
2. Natural Resources	(N=66)	6	26	34	If yes->	6	0	0
3. Health Protection or Sanitation	(N=63)	16	18	29	If yes->	12	4	0
4. Agriculture	(N=70)	20	15	35	If yes->	16	4	0
5. Occupational Health and Safety	(N=68)	26	13	29	If yes->	16	9	1
6. State Grantee--Agency for Toxic Substances and Disease Registry (ATSDR)	(N=64)	40	7	17	If yes->	33	6	1*
7. State Grantee--Environmental Protection Agency (EPA)	(N=62)	24	9	29	If yes->	18	4	2*
Academic organization								
8. State University or Medical School	(N=72)	42	7	23	If yes->	34	6	2*
9. Private University or Medical School	(N=62)	19	8	35	If yes->	11	7	1*
10. Other--please specify ____	(N=19)	4	6	9	If yes->	4	0	0

*These individuals did not answer Part B.

10. Consider all the exposure-related studies, investigations, and surveillance efforts you have conducted since January 1996. In these efforts how often could you include human exposure data from human tissue samples when you thought it was important?

(N=80) *(check one)*

- 13 Always or almost always
- 5 Over half of the times
- 10 About half of the times
- 21 Less than half of the times
- 31 Seldom, if ever

11. For the exposure-related work you have conducted since January 1996, list below up to 5 chemicals for which you could not use human exposure data when you thought it was important. Please include chemicals that, in your opinion, might pose a significant health risk to residents or communities in your state.

(N=42) *(list up to 5 chemicals)* _____

12. Listed below are reasons that might prevent a public health official from using human exposure data in a study, investigation, or surveillance effort. Indicate which, if any, account for why you have not used human exposure data when you thought it was important.

(N=75) *(check all that apply)*

1. 32 Insufficient numbers of epidemiology staff trained to design and implement studies and analyze data
2. 22 Insufficient numbers of state public health laboratory staff trained to analyze samples
3. 20 No equipment in our state public health laboratory needed to analyze samples
4. 22 No laboratory methods (assays) to test human samples for chemicals we want to study
5. 46 Lack of information on the distribution of exposure—reference ranges—among the general population to compare with measurements from our work
6. 45 Lack of research to link chemicals we want to study with specific human health effects
7. 28 Information on concentrations of chemicals in environmental media are not sufficiently detailed
8. 21 Lack of protocols, training, or equipment to collect and store samples
9. 37 Large number of samples needed would be too expensive or overwhelm available laboratory capacity
10. 19 Too difficult to obtain informed consent from potential participants
11. 19 Division of responsibility for health and environmental protection among different state agencies makes such studies difficult to undertake
12. 29 Other—please specify _____

13. Of the reasons you checked in question 12, indicate which items were most important in your decision not to use human exposure data when you thought it was important.

(list up to three of the numbered items you checked in question 12)

74, 64, 54

14. Are there environmental health concerns your state does not address that you think it should?

(N=73) *(check one)*

42 Yes → please specify _____

31 No → go to question 16

15. Describe below why your state is not addressing environmental health concerns you think it should.

(N=45) _____

16. If you have any additional comments about the role of human exposure data in the study of environmental health concerns or your office's ability to make use of such data, please write them in the space provided below.

(26 respondents provided comments; 55 respondents did not provide comments)

Thank you for participating in this study.

Appendix IV

Comments From the Department of Health and Human Services

DEPARTMENT OF HEALTH & HUMAN SERVICES

Office of Inspector General

Washington, D.C. 20201

APR 24 2000

Ms. Janet Heinrich
Associate Director, Health Financing
and Public Health Issues
United States General
Accounting Office
Washington, D.C. 20548

Dear Ms. Heinrich:

Enclosed are the Department's comments on your draft report, "Toxic Chemicals: Long-Term Coordinated Strategy Needed to Measure Exposures in Humans." The comments represent the tentative position of the Department and are subject to resvaluation when the final version of this report is received.

The Department also provided extensive technical comments directly to your staff.

The Department appreciates the opportunity to comment on this draft report before its publication.

Sincerely,

Michael Mangano
for June Gibbs Brown
Inspector General

Enclosure

The Office of Inspector General (OIG) is transmitting the Department's response to this draft report in our capacity as the Department's designated focal point and coordinator for General Accounting Office reports. The OIG has not conducted an independent assessment of these comments and therefore expresses no opinion on them.

Comments of the Department of Health and Human Services on the General Accounting Office Draft Report Entitled, "Toxic Chemicals: Long-Term Coordinated Strategy Needed to Measure Exposures in Humans" GAO/HEHS-00-80

General Comments

The Department of Health and Human Services (the Department) thanks the General Accounting Office (GAO)for providing the opportunity to comment on their draft report. In general, the report is an accurate and forward-thinking document. The issues that surround the need for a coordinated strategy to measure exposures in humans are important to real public health concerns, and this report will hopefully energize the evolution of ongoing efforts within the Department and the Environmental Protection Agency (EPA).

The Department agrees that GAO's decision to focus on nonoccupational environmental exposures in the report is appropriate, but it may be worth mentioning that a coordinated Federal effort in human exposure monitoring should be linked if not tied directly to Federal efforts that monitor or evaluate occupational exposures. While there are many good reasons to distinguish the two types of exposures, it is important to realize that public health is best served if Federal efforts that focus on occupational and nonoccupational exposures do not operate in isolation.

The GAO report appropriately focuses on Federal efforts that directly attempt to monitor human exposures on a national scale. As stated in the report, the many basic scientific advances in human exposure research, as well as research establishing linkages between environmental exposures and adverse health effects that are essential for State and Federal agencies to make decisions regarding public health, will come from a coordinated Federal effort in human exposure monitoring. It is also important to realize that such advances have in the past and will continue to result from federally-sponsored and private sector research.

The Department agrees with the emphasis placed on at-risk populations and the recommendations made regarding the opportunities for exposure assessment to provide a better base from which to address at-risk populations. We also believe that the report could emphasize the importance of developing a breast milk monitoring program. Many environmental agents are fat soluble and are released into breast milk at significant concentrations. Examples include dioxins and polychlorinated biphenyls (PCBs) where 6 months of nursing results in dioxin or PCB concentrations in infants which are ten times higher than in the mother. Information on chemicals present in breast milk and trends over time would be valuable information in establishing priorities and strategies for children's health programs (see Hooper and McDonald, Environmental Health Perspectives, 108(5) 387-92, 2000).

The GAO report's comments on the effectiveness of Federal/State interactions on exposure assessment issues are clearly on target. In addition to the points made in the GAO report, we believe that a number of other issues could be emphasized. These include the direct application of exposure information to fill knowledge gaps that create uncertainties in risk assessment. For example, there is increasing use of margin of exposure analysis in risk assessment guidelines for

both State and Federal regulatory agencies. Information on blood and urine levels in generalized or specific populations is essential for rational use of margin of exposure analysis. These kinds of data would also improve the ability of State agencies to monitor the effectiveness of regulations setting acceptable ambient levels at the fencelines of industrial facilities. Improved availability of exposure information would provide more credible ways for States to set fish advisories for agents such as methlymercury. This is important because fish is a good source of dietary protein and consumption of fish should only be discouraged when necessary because of mercury contamination.

The GAO report could better characterize how the Department's Centers for Disease Control and Prevention (CDC) has enabled other agencies to use human tissue measurements through interagency collaborations and agreements. While this is mentioned for the National Institute of Environmental Health Sciences (NIEHS), it is not well described for EPA's National Human Exposure Assessment Survey (NHEXAS) pilots or for the Agency for Toxic Substances and Disease Registry.

We do not believe that the GAO report clearly conveys the broad scope of the National Health and Nutrition Examination Surveys (NHANES). The NHANES has many objectives, only one of which is monitoring environmental exposures. A reader of this report who is not familiar with NHANES would likely come away with the impression that the primary purpose of NHANES is to monitor environmental exposures. This impression comes about particularly because of the tendency in the report to compare NHANES to EPA's NHEXAS, which is devoted solely to exposure monitoring.

To illustrate the breadth of NHANES, the following is a list of diseases, medical conditions, and health indicators that NHANES examines in addition to environmental exposures: anemia, cardiovascular disease, diabetes, equilibrium, HIV seroprevalence, infectious diseases and immunizations, urologic disorders, mental health, nutrition and dietary behaviors, obesity, oral health, osteoporosis, physical fitness, reproductive history, respiratory disease, sexually transmitted diseases, skin diseases, tuberculosis, and vision and hearing problems.

One issue not explicitly discussed in GAO's report but which results in difficulties in using NHANES for monitoring environmental exposures relates to NHANES' relatively small yearly sample size. For example, in any 1 year, even for some exposures for which the entire sample is tested, the sample size will not allow yearly estimates by multiple demographic domains simultaneously. The full range of options should be considered when addressing how to improve the ability of the Federal Government to monitor environmental exposures. One option that should be seriously considered is to take advantage of the substantial investment already made in the NHANES infrastructure and substantially increase the sample size. If accompanied by a substantial investment in laboratory capacity, the increased sample size would greatly increase the ability of NHANES to provide expedient data on exposures for major demographic subgroups.

Exposure data is valuable to the process of identifying people being exposed to hazardous substances in the environment and the needed health follow-up actions to address these

exposures. Therefore, the findings and recommendations of GAO's report should help to ensure that the Department continues to make progress to enhance the collection of, the methodology development for, and the utility of environmental human exposure data. We look forward to working with our partners in the Federal and State governments to address the recommendations set forth in GAO's report.

GAO Recommendation

We recommend that the Secretary of HHS and the Administrator of EPA develop a coordinated federal strategy for the short- and long-term monitoring of human exposures to potentially toxic chemicals.

Department Comment

The Department concurs that there is a need for a viable short- and long-term strategy for monitoring human exposures. While improved coordination may be useful, coordination alone would only be the first step in the process. Improved coordination would likely produce agreement on the need to improve laboratory capacity, to develop methods for monitoring of more chemicals, to undertake monitoring of additional chemicals, and perhaps to increase sample size. As a practical matter, however, these improvements will not occur without addressing the problem of limited resources as mentioned in the report.

Resources needed to enhance coordination should not be taken from existing limited resources in such a manner that might diminish ongoing analyses and programmatic efforts. We believe the report should make a clear statement that human tissue measurements of exposure to contaminants is essential to all agencies, and that future interagency coordination should be based on the value of using human measurements of exposure assessment to achieve agency goals.

Additionally, the Department believes that this recommendation overlooks the enormous amount of work already done toward this end, especially at the CDC. The EPA and NIEHS sit on the advisory board of CDC's National Center for Environmental Health to make sure efforts are coordinated between the organizations. The CDC has performed all the biomonitoring measurements in the NHEXAS study and has had numerous discussions, including ongoing ones, of how CDC measurements could be used in future exposure assessments of the United States population and at-risk populations. This recommendation is partially being met now, but we could always do better at it.

GAO Recommendation

We further recommend that the agencies identify common or complementary performance goals or measures to reduce, monitor, or develop methods for measuring human exposures to toxic chemicals.

Department Comment

The Department concurs that any effort undertaken as a result of the first recommendation should have performance goals.

General Comment on Recommendations

Even if the Department and EPA were to successfully and efficiently implement the preceding recommendations, there would be no guarantee of the collection and use of important human exposure data to prevent disease and death. The GAO identified in its report the large need for "expanded" scientific effort (not just coordinating existing efforts) to address the more than 1400 chemicals identified by agencies as high priority. The Department believes that this expanded scientific effort is crucial if substantive progress is to be made.

Appendix V

Comments From the Environmental Protection Agency

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

APR 20 2000

OFFICE OF
RESEARCH AND DEVELOPMENT

Ms. Janet Heinrich
Associate Director, Health Financing and Public Health Issues
Health Education and Human Services Division
General Accounting Office
441 G Street N.W.
Room 5A36
Washington, DC 20548

Dear Ms. Heinrich:

We appreciate having been given the opportunity to review and comment on the draft April 2000 report entitled, "Toxic Chemicals: Long-Term Coordinated Strategy Needed to Measure Exposures in Humans," and congratulate the GAO on their insightful review. We greatly appreciate the professionalism of the GAO auditors, as well as their efforts to keep us informed and consider our views.

The GAO captured the essence of the issues associated with obtaining human exposure data, with one significant exception, namely an over-emphasis and reliance on the measurement of pollutants in blood/tissue/urine, i.e., biomarkers (see enclosure General Comment 2 for more on this issue).

We strongly support the general conclusion that far more research is needed to understand human exposures to potentially dangerous chemicals and the recommendation that the "Secretary of HHS and the Administrator of EPA be charged with developing a coordinated federal strategy for the short- and long-term monitoring and reporting of human exposures to potentially toxic chemicals." The recommendations include reports on levels and trends of exposure and identifying the need to develop common, complementary performance goals or measures related to collecting and using human exposure data. To be consistent, we would urge that the specific guidance about increasing coordination (page 4) also include the concept presented in the main text that efforts need to be expanded, rather than merely coordinated (e.g., first bullet on page 42).

Now on page 6.

Now on page 41.

As mentioned in your report, HHS and EPA initiated discussions last fall on the need for an integrated, interagency program on human exposure. Under the auspices of the Toxics and Risk Subcommittee of the Committee for the Environmental and Natural Resources, a small working

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group has been developing a framework document that will hopefully serve as the basis for expanded discussions across the Federal government and with other key stakeholders (e.g., states). The GAO report reinforces the timeliness and appropriateness of this understanding.

We offer additional general and technical comments for your consideration in the enclosure. Dr. Harold Zenick will continue to serve as the overall lead for my office, while Dr. Judy Graham will serve as the technical lead. Please feel free to contact them at (919) 541-2283 and (919) 541-0349, respectively, if additional clarification of our comments is needed. Again, thank you for considering these comments as you finalize this report.

Sincerely,

Norine E. Noonan

Norine E. Noonan, Ph.D.
Assistant Administrator

Enclosure

3

Enclosure

EPA Comments on GAO Draft Report
Toxic Chemicals
Long-Term Coordinated Strategy Needed to Measure Exposures in Humans
(GAO/HEHS-00-80)

General Comments

- Need additional federal partners. We request that the GAO consider the benefits of the participation of additional federal entities with interests in improved knowledge of exposure, such as the Department of Defense (e.g., de-contamination of bases and knowledge requirements relative to clean-up), the Department of Transportation (pollution related to where roads and highways may be constructed/expanded including associated commercial/industrial activities that may follow) and the Department of Energy (e.g., radiation exposures). Also, the report emphasizes environmental exposure, without commenting on occupational exposure. Risks result from total exposure to chemicals, making it important to public health to determine whether a person is also exposed occupationally. Scientifically, there is a growing merger of occupational and environmental exposures, as the workplace shifts from a factory to an office building to a residence. When performing a measurement study, all these elements should be considered.

- Limitations of biomarkers. For selected chemicals and applications, biomarkers are very useful and probably the best measure of exposure. However, there are other measures of human exposure that may be better suited, less burdensome, provide more information, or are less costly for many applications. As examples, for exposure to volatile organic compounds, for which inhalation is expected to be the primary route, passive personal air monitors may be the better choice. For pesticides which are rapidly excreted from the body and for which intermittent exposures are expected, passive integrated air or dust samples may provide more useful information. Finally, there are thousands of chemicals having no current biomarkers of exposure. For these chemicals, at least in the short-run (the next 10 years), other measures of exposure must be used. We believe that for each chemical, the study objectives need to be decided, the available methods for measuring exposure evaluated, and the most appropriate method selected. We do not believe that biomarkers should be selected *a priori* as the best method in all cases. In fact, the preferred situation may be to obtain an integrated suite of measures that allow for better understanding and interpretation of exposures related to a particular chemical/class of chemicals.

  Where biomarkers are available, they may be very useful if exposure can be quantified, interpreted, and the sources of personal exposure identified. For example, the mere presence of a chemical in blood does not denote toxicity: certain concentrations (unknown for most biomarkers) indicate a potential for an adverse health outcome. The need to place biomarkers

4

Now on page 5.

in a health context is also mentioned by state officials (page 4). Source identification is needed so that the cause of excessive exposure can be identified and prevented. If high levels of biomarkers are observed, it is essential to know whether they resulted from, for example, inhalation exposure from industries in the vicinity or food contamination. Such knowledge is fundamental to cost-effective corrective/preventive action. The need to make biomarkers part of a more comprehensive monitoring program has been identified by the NRC (footnote 4 at bottom of page 5) and EPA's Scientific Advisory Board (footnote at the bottom of page 34).

Now on page 7.

Now on page 31.

Biomarkers measure the amount of chemicals remaining in the body at the time of the measurement. Some chemicals, notably lead and dioxin, remain in the body for long periods of time following exposures. These tend to provide an index of "long-term" (i.e., months to years) exposures, and integrate over multiple exposure events. Others, notably "non-persistent" pesticides, are excreted within hours or days after the exposure. For these chemicals, changes over time may be more closely related to the duration of a specific exposure event, rather than to changes in population exposure measurements over time. In such cases, if the sampling time is very different from the exposure event, the exposure may go unrecognized.

See page 26.

- Information Needed to Interpret Human Exposure Measurements (p. 25 ff). This section contains several excellent examples of how knowledge of biomarkers was useful to officials concerned with pollution from point sources. For example, a nearby waste site was suspected to contaminate people living nearby. Blood of residents was examined for those few chemicals at the site of interest. This shows how biomarkers can be used along with additional exposure information to identify potential problems and mitigate exposure and health risks. In this example, information had already been collected on the source of the chemicals, the time frame of exposure, the proximity of the individual to the source, and the potential routes of exposure. To extend this concept to a general population survey, we would also need to collect similar information on potential sources and routes of exposure, along with biomarker levels. Measuring biomarkers alone would not enable officials to take protective action for chemicals having ubiquitous sources or multiple pathways of exposure. For example, pesticide exposure can result from contaminated air, water, soil, and food. Thus, if blood levels of a certain pesticide are very high, was this due to a nearby waste site or a transport through the air or track-in of contaminated soil?

- Future NHEXAS and NHANES. The primary goal of NHANES is to collect information on the health and nutritional status of the U.S. population with the goal of monitoring exposures being secondary. Exposure data can only be collected in NHANES if it imposes a minimum burden on the study participants and does not interfere with the primary data collection goals. This constraint limits the amount of a sample that can be collected for measuring biomarkers which in turn limits the number of biomarkers that can be measured. Because of "participant burden", it also severely limits the number and types of personal exposure monitoring samples that can be collected and the number of survey questions that can be asked about

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exposure and potential sources. While the NHANES environmental goal appears to be similar to that of NHEXAS, the NHEXAS approach provides information about both the distributions and the determinants of human exposures (i.e., sources, environmental concentrations, and activities). We are impressed by NHANES increased emphasis on monitoring for chemicals and EPA has provided some financial support for it. However, there are still profound differences in the level of attention that NHANES can pay to environmental exposures and still maintain their other multiple (and worthy) goals.

Appendix VI

Major Contributors to This Report

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Staff Acknowledgments

The following individuals made important contributions to this report: Frank Pasquier served as Assistant Director; Cheryl Williams, Senior Evaluator, performed the literature review, assessed barriers, performed state site visits, and—along with Anita Kay, Intern—administered the survey of state environmental health officials; Tim Clouse, Evaluator assessed federal efforts and evaluated information collected for identifying at-risk populations; Sharon Silas, Intern, and Evan Stoll, Technical Analyst, compiled and analyzed the lists of toxic chemicals; Sylvia Shanks served as attorney-adviser, and Stan Stenersen guided the message development and report writing.

STATEMENT OF STEPHEN M. PRESCOTT, M.D., EXECUTIVE DIRECTOR, HUNTSMAN CANCER INSTITUTE

This year, approximately 2,400 children in the United States will be diagnosed with acute lymphoblastic leukemia (ALL), the most common form of childhood cancer. Their chances for cure are significantly better than they were three decades ago. Due to breathtaking progress in research, close to 75 percent of these children will grow up to lead healthy productive lives. The results are improving each year and childhood ALL is one of the most curable forms of human cancer.

Despite this success, many challenges remain and the first is obvious—the cure rate isn't 100 percent. And, until it is we must work toward this goal. A second goal is to develop treatments with fewer side effects. To achieve these goals we must discover the root causes of childhood leukemia. In this regard, the future is bright. We are beginning to unravel the events that cause a single cell to become cancerous. These results can be attributed to significant advances in basic research, especially in the area of genetics. When we talk about cancer genetics we mean two different things. The first, which is readily understood, means inheriting a high risk of cancer from one's parents. This is only a small minority of all cancer cases and is very rarely the cause of childhood cancer. The second meaning of genetic is that the cancer cell has acquired damage to its genes, while the rest of the body's cells have a perfectly normal genetic make-up.

In the case of ALL, we know that a single normal cell, destined to become a normal white blood cell called a lymphocyte, develops a mistake in the genetic code. In the case of leukemia, this is a swap of genetic material between two chromosomes and is called a translocation. These translocations occur in genes that control growth under normal circumstances. When such growth-promoting genes are damaged, the cell will continue to grow even when the body is trying to send a message to tell it to stop growing. Through the development of powerful techniques we now know the location of many of these defects and researchers at many centers are working to unravel the complexity of the cancer cell to understand specifically changes that allows the cancer to grow.

Perhaps the most difficult questions for a physician to answer are, "Doctor, why did my child get leukemia? And, was there anything I could have done to prevent it"? The answer to the second is a resounding "no." The answer to "why" is that we don't yet know the fundamental cause of ALL.

When clusters, or dramatic increases in cancer cases in small geographic areas, occur, we always revisit the issue of whether a cancer-causing agent from the environment or an infection resulted in the increased number of cases. Unfortunately, this approach has not identified any causes for ALL. But it is possible that we are missing subtle relationships if an environmental or infectious cause is present but only affects individuals with a certain genetic makeup and not all members of the population.

The recent sequencing of the human genome provides us with unprecedented opportunities to understand cancer and to use that knowledge to develop new treatment and prevention. The major focus of the Huntsman Cancer Institute (HCI) is to understand this genetic blueprint of cancer. Using a new technology called "DNA chips" investigators in our childhood cancer program have uncovered genetic pathways that are active in cancer cells but not normal blood cells. Using this information it may be possible to develop drugs that could interfere with these active pathways. Since these changes are limited to the cancer, new drugs targeted to these pathways might avoid the side effects seen with conventional drugs.

We also now know that certain pathways are unique to groups of patients that have a greater risk of relapse after treatment. It may be possible to use the genetic "fingerprint" of the leukemia someday to "tailor" therapy so that patients with a high likelihood of cure can be treated without exposing them to unnecessary more toxic therapy, while patients with high risk disease can be more effectively treated before the leukemia comes back. This approach is still experimental and leukemia samples from children treated at children's hospitals throughout the United States will be sent to us to test further this genetic approach to classifying leukemia. We believe that the same approach could be applied to studies of clusters of ALL to try to understand why they occur. For example, is there a specific genetic pathway damaged in children from Fallon who have ALL. If so, this would suggest that an infection or environmental agent initiated a common form of damage.

The Children's Oncology Group, a consortium of all major children's hospitals in North America, is embarking on a massive effort to identify a subset of patients who might be especially vulnerable to environmental risks because of inherent susceptibility to damage from chemicals. This effort will use the approach I've described and

will be led by Dr. Bill Carroll, the deputy director of the Huntsman Cancer Institute.

Although these projects are just underway, progress is being achieved at a remarkable rate. By combining sophisticated genetic analysis of patients and their tumors with the best treatments available, we hope to reach that goal of uniform cancer cure and ultimately, prevention.

ENVIRONMENTAL EXPOSURES AND CHILDHOOD CANCER: OUR BEST MAY NOT BE GOOD ENOUGH

Childhood cancer ranks high among public concerns, evoking the public's fear of cancer as well as the special emotional attention that is focused on children. Although it is rare, its priority is elevated on the basis of years of life lost and its prominence among life-threatening diseases of children. Despite great success in the treatment of childhood cancers such as Wilms' tumor and leukemia, cancer continues to be life threatening in children.

For several decades, clusters of childhood leukemia have been investigated, in a search first for an infectious etiology and then for an environmental etiology,[1] both without success. Childhood cancer clusters continue to generate public concern and consume health department resources, but there has been little progress in understanding the etiology or identifying preventive measures. The focus often turns to the role of environmental pollutants such as pesticides, electromagnetic fields, and chemicals found in hazardous wastes. The rationale for seeking exogenous, modifiable causes of childhood cancer that can be avoided leading to a reduction in the risk of disease, is compelling. The negative consequence of such public demand and support for epidemiologic research is the temptation to overinterpret every shred of fallible evidence that emerges. The public and media tend to place much more faith than is warranted in isolated findings, to the detriment of sound policy and the credibility of researchers.

Epidemiologic research into potential environmental contributors to the etiology of childhood leukemia, brain cancer, and other pediatric malignancies has been pursued intensively for over 20 years. Motivated by scientific interest and public concern, a number of studies have evaluated the role of pesticides,[2] ionizing radiation,[3] nonionizing radiation,[4–5] and a wide range of occupational and environmental exposures.[6–7] Dozens of epidemiologic studies have been conducted on these topics, some with sophisticated designs, large populations, and attention to exposure assessment, such as the report in this issue by Freedman et al.[8] on solvent exposure and childhood acute lymphoblastic leukemia.

SCIENTIFIC CHALLENGES TO IDENTIFYING CAUSES OF CHILDHOOD CANCER

The scientific challenges to identifying environmental contributors to the etiology of childhood cancer are daunting. We are uncertain about the relative importance of exposures of the mother, father, and child in disease etiology. Although the time frame is narrower than the half century of potential relevance in the etiology of adult cancer, the origins of childhood cancer may lie anywhere between conception and diagnosis. The appropriate disease entities for study cannot be defined with confidence, so histology, age of onset, and tumor biology are all potential markers of etiologic heterogeneity. The goal of creating ever-finer case subgroups must be reconciled with the overall variety of cancers in children. The trade-off is between potential gains in validity achieved by creating more homogeneous case groups and a definite loss of precision as the group size is reduced.

Because childhood cancers are so rare, true prospective studies are virtually impossible, necessitating continued reliance on case-control studies. As noted by Freedman et al.,[8] the 2 key challenges associated with that design are control selection and exposure assessment. Except in locations with complete birth registries or population rosters (mostly in northern Europe), identifying and recruiting a sample of the case-generating study base pose great challenges.

Hospital-based studies make it impossible to define the source of cases, particularly for diseases that result in referrals from a wide geographic area. Because few children are hospitalized for any reason, finding "exposure-neutral" diagnostic groups of children as a source of controls is even more challenging than it is for adults. In population-based studies, nonresponse is inevitable, often reaching levels of 20 percent to 40 percent of the eligible population. As a reminder that this nonresponse is capable of distorting measures of association, virtually all case-control studies of childhood leukemia in the United States, including the study by Freedman et al., have found higher risk in the lower social classes, despite there being an established, though modest, positive correlation between higher social class and risk for child cancer on the basis of registry information. The overrepresentation of

upper-social-class controls, stronger than the corresponding trend among cases, appears to be the source of this effect, replicated across studies. Adjustment for social class can be made, but this consistent observation suggests that other aspects of nonresponse (particularly among controls) may well have more insidious effects.

The second consequence of conducting case-control studies is the loss of information associated with retrospective exposure assessment. Until the cancer is identified (or the control child reaches the equivalent age), we can not ascertain exposure and are thus faced with reconstructing exposure throughout the potential etiologic period. Studies that identify the cases as they are diagnosed, as was done by Freedman et al.,[8] avoid the additional time delay associated with recruiting cases diagnosed before the initiation of data collection, but there is still a limit to the accuracy of exposure assessment for periods extending back as far as 15 years. Biological markers of exposure are clearly not applicable, and direct measurement of environmental agents in the physical locations of interest is of uncertain relevance owing to the passage of time. We are forced to relay on memory, which itself is limited in accuracy and objectivity with regard to the important details about workplaces and the home environment that can affect exposure.

SOLVENTS AND CHILDHOOD LEUKEMIA

Recognizing all these limitations, the report by Freedman et al. reflects the "state of the art" in childhood cancer epidemiology with regard to study size (640 cases included in the analysis), homogeneity of disease classification (all acute lymphoblastic leukemia), method of control selection (random-digit dialing), and approach to exposure assessment (structured questionnaire addressing frequency and duration of exposure). As would be predicted, the greatest concerns with bias arise from nonresponse and exposure misclassification. Only 64 percent of eligible controls were enrolled, and despite some evidence against the available measures of social class being associated with solvent exposure, that level of nonparticipation leaves open the possibility of distorted results. Relative to an ideal measure of actual solvent exposure, as might be obtained through personal monitoring, the effectiveness of the exposure assessment questions is uncertain. The investigators focus on differential error, which could contribute to elevated measures of association, but nondifferential misclassification is more certain to be present and can be invoked as an argument that observed associations are more likely to be underestimates of any underlying causal association.

This study advances the hypothesis that solvent exposure may contribute to the etiology of childhood leukemia, moving it from a plausible hypothesis with no direct epidemiologic support to one with very limited epidemiologic support. The total evidence supporting the hypothesis that household solvent exposures cause childhood leukemia nevertheless remains weak but deserving of further study. Perhaps the most disconcerting challenge posed by the study is how to make progress in evaluating the hypothesis further. The very strengths of the study by Freedman et al. make it difficult to suggest improvements. Certainly, pure replication, assessing whether the same study design generates the same results in other settings, would be welcome. There is clearly some room for refinements in the approach to exposure assessment, with more detailed query pertaining to exposure determinants. Those who are already engaged in such studies would do well to include pertinent questions regarding household solvent exposure. However, given the rarity of the disease and the expense associated with studies of this size, it is difficult to advocate initiating new studies with household solvent exposure as a primary justification.

Even though the epidemiologic studies directly tackle the exposure and disease of interest, more insight may be generated by strong findings of indirect relevance than by more weak findings of direct relevance. Research that addresses the impact of self-reported activities on measured solvent exposure would be highly beneficial to interpreting this study and could lead to improved methods of retrospective exposure assessment. Toxicologic studies of implicated agents, such as methylene chloride and benzene, focusing on animal models of childhood leukemia may help in the interpretation of these results. For a possible paternally mediated pathway linking solvent exposure to childhood leukemia, further work on sperm-mediated genetic alterations associated with solvent exposures could be contributory. With regard to childhood exposure, focus might shift to endpoints that can measured prospectively in modest populations, ideally, biomarkers of early effect such as cytogenetic damage. If we are to attain the conclusive results pertaining to solvent exposure (or pesticides, nonionizing radiation, etc.) and leukemia (or other childhood cancers)—an elusive goal so far—it is very unlikely to come through sheer weight of replicated findings from conventional epidemiologic studies.

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Household Solvent Exposures and Childhood Acute Lymphoblastic Leukemia

ABSTRACT

Objectives.—This study explored the risk of childhood acute lymphoblastic leukemia (ALL) associated with participation by household members in hobbies or other home projects involving organic solvents.

Methods.—Participants in this case—control study were 640 subjects with ALL and 640 matched controls.

Results.—Childhood ALL was associated with frequent (>4 times/month) exposure to model building (odds ratio [OR]=1.9; 95 percent confidence interval [95 percent CI]=0.7, 5.8) and artwork using solvents (OR=4.1; 95 percent CI=1.1, 15.1). We also found elevated risk (OR=1.7; 95 percent CI=1.1, 2.7) among children whose mothers lived in homes painted extensively (>4 rooms) in the year before the children's birth.

Conclusions. In this exploratory study, substantial participation by household members in some common household activities that involve organic solvents was associated with elevated risks of childhood ALL. (Am J Public Health. 2001;91:564-567)

Little is known about the role of environmental exposures in childhood leukemia.[1] Several epidemiologic studies have described elevated risks of childhood leukemia associated with parents' exposure to occupational chemicals, [2–10] including solvents [3,6,8,9] and paints.[3,5,7,10] Children may also be exposed to solvents and paints at home through their own or their parents' hobbies and household maintenance activities. To our knowledge, few studies [10] have examined the risks of childhood leukemia associated with exposures to solvents in the home other than pesticides.

As part of a large comprehensive case-control study of potential risk factors for childhood acute lymphoblastic leukemia (ALL) conducted by the Children's Cancer Group, we undertook an exploratory study to examine the relationship between childhood leukemia and exposure to selected household chemicals during childhood, as well as indoor house painting during preconception, pregnancy, and childhood. We focused on common home activities likely to result in exposures to solvents.[11–14]

METHODS

Case subjects were children, aged birth to 14 years, who were newly diagnosed with ALL between 1989 and 1993, resident in any of 9 midwestern and mid-Atlantic States, and enrolled through the Children's Cancer Group, a cooperative clinical trials group.[15,16] Eligibility criteria included a residential telephone and an English-speaking biological mother available for an in-person interview. Control subjects were selected through random-digit dialing and were individually matched to the case subjects by age (within 25 percent of the case's age at diagnosis), the first 8 digits of the telephone number, and race.[17] The overall participation rates were 88 percent for case subjects and 64 percent for control subjects. After exclusion of pa-

tients with Down syndrome, which has been associated with a high risk of ALL,[18] there were 640 matched case-control pairs.

For each of 3 hobbies (model building, artwork using solvents, and furniture stripping) and 2 household maintenance activities (motor vehicle and electronic equipment repair), interviewers asked mothers whether household members engaged in any of the 5 activities in and around their home. Because pretesting revealed that many mothers could not remember early activities or gave identical answers for each year of the child's life, the interview focused on activities during the reference year (the year preceding the date of diagnosis for the case and its matched control). Interviewers asked the mother about which household members participated in the activities, as well as the frequency and duration of each episode. Interviewers also asked questions about painting inside the subjects' homes within 3 months of conception, during the pregnancy, and after the subjects' birth, including the specific rooms painted, the frequency of the painting, who painted (mother or others), and whether members of the family remained at home overnight during the house painting.

For each hobby or household activity other than house painting, we analyzed 2 measures of exposure: frequency (defined as the number of times engaged in the activity per month) and cumulative exposure (defined as the product of the frequency of the activity and its duration per episode). Because fewer control than case mothers provided information about duration, our analysis emphasized frequency as a more unbiased exposure measure. Before any analysis, we arbitrarily classified frequency and cumulative exposure into common time categories. We categorized frequency of exposure as low (<1 time/month), medium (1–4 times/month), and high (>4 times/month); we categorized cumulative exposure as low (<10 minutes over a month), medium (10 minutes–1 hour over a month), and high (>1 hour over a month). For house painting, exposure was classified by the total number of rooms painted (1–2, 3–4, >4 rooms), as well as the frequency (1–2, 3–5, >5 times since birth) among those painting after the child's birth.

We computed odds ratios by unconditional logistic regression so as to maximize the number of cases and controls included in this exploratory analysis. We confirmed our main findings by conditional logistic regression. Odds ratios were adjusted for age at the reference date, sex, mother's education level, and family income. We compared subjects by whether they ever or never participated in a given activity and by the 2 measures of exposure. We analyzed the total population, as well as 2 age strata: younger than 5 years (the peak ages are 2–4 years for ALL) and 5 years and older. Except for model building, there was an insufficient number of children participating in the various activities to assess the risk of ALL among child participants. For house painting, we investigated the timing of painting before and after birth.

We also examined 2 strata based on length of time between diagnosis and interview (≤24 months vs >24 months). We explored trends in risk by entering exposure variables ordinally into the models.

RESULTS

Case subjects and control subjects were demographically similar, except that the former came from families with lower income and had mothers with less formal education. Both groups were predominantly White (Table 1).

Exposures From Hobbies, Vehicle Maintenance, and Electronic Repair

No significant excess risk of childhood ALL was observed with ever vs never participation in any of the activities by a household member (Table 2). Moreover, neither automotive and truck maintenance nor electronic repairs reflected a pattern of risk with increasing exposure.

Elevated risks of childhood ALL, however, were associated with the highest levels of participation in some activities (Table 2). Risks were elevated for model building in the highest-frequency category (odds ratio [OR] = 1.9; 95 percent confidence interval [CI]=0.7, 5.8) but did not vary by age group or the child's involvement. Artwork requiring solvents was linked with significantly elevated risks of childhood ALL in the highest-frequency exposure category (OR=4.1; 95 percent CI=1.1, 15.1), and risks increased as exposure rose (*P* trend=.07). Although the numbers were small, similar risks were observed in both age groups (data not shown). The associations with high cumulative exposure were similar to those with frequent exposures for both model building and artwork (data not shown).

For furniture stripping, risk was not elevated among children in families with the highest frequency of exposure. Risk was, however, significantly elevated among children in those families with the highest cumulative exposures (OR=2.9; 95 percent CI=1.1, 9.1).

In general, when the subjects were stratified by time between diagnosis and interview dates, the odds ratios among those interviewed close to the diagnosis date were about the same as or stronger than the unstratified odds ratios.

TABLE 1.—Characteristics of 840 Children With Acute Lymphoblastic Leukemia and 640 Matched Controls,[a] From Interview Data on Use of Household Solvent Exposures

Characteristics	Cases N (%)	Controls N (%)
Sex:		
Male	333 (52.0)	337 (52.7)
Female	307 (48.0)	303 (47.3)
Age at diagnosis/reference date, y:		
<2	68 (10.6)	85 (13.3)
2–4	312 (48.8)	289 (45.2)
5–9	179 (28.0)	185 (28.9)
5≥10	81 (12.7)	81 (12.7)
Race:		
White	585 (91.4)	612 (95.8)
Black	20 (3.1)	16 (2.5)
Other	35 (5.5)	12 (1.9)
Household income during reference year, $:		
<20,000	113 (17.7)	77 (12.0)
20,000–29,999	122 (19.1)	86 (13.4)
30,000–39,999	133 (20.8)	112 (17.5)
40,000–49,999	98 (15.3)	105 (16.4)
≥50,000	168 (26.2)	255 (39.8)
Missing	6 (0.9)	5 (0.8)
Mother's education:		
<High school	57 (6.9)	30 (4.7)
High school	220 (34.4)	224 (35.0)
Some college	210 (32.8)	199 (31.1)
College graduate	153 (23.9)	187 (29.2)
Mother's occupation:		
Professional	131 (20.5)	148 (23.1)
White collar	156 (24.2)	172 (26.9)
Blue collar	45 (7.0)	29 (4.5)
Housewife	308 (48.1)	291 (45.5)
Father's occupation:		
Professional	190 (29.7)	200 (31.3)
White collar	103 (16.1)	119 (18.6)
Blue collar	285 (44.5)	240 (37.5)
Missing	62 (9.7)	81 (12.7)
Residential status:		
Urban	169 (26.4)	136 (21.3)
Suburban	271 (42.3)	293 (45.8)
Rural	200 (31.3)	210 (32.8)
Time between reference date and interview, mo:		
7–12	86 (13.4)	3 (0.5)
13–18	256 (40.0)	107 (16.7)
19–24	134 (20.9)	196 (30.6)
25–36	129 (20.2)	238 (37.2)
≥37	35 (5.5)	96 (15.0)

[a] Excludes 11 pairs in which 1 member of the air had Down syndrome.

TABLE 2.—Distribution of Cases and Controls by Frequency[a] of Hobby and Household Maintenance Activity During Year of Diagnosis, With Odds Ratios[b] (ORs) and 95% Confidence Intervals (CIs)

	Cases	Controls	OR(95% CI)
Hobbies			
Model building:			
Never[c]	549	555	1.0
Ever[d]	90	83	1.1 (0.8, 1.5)
Low	51	60	0.9 (0.6, 1.3)

TABLE 2.—Distribution of Cases and Controls by Frequency[a] of Hobby and Household Maintenance Activity During Year of Diagnosis, With Odds Ratios[b] (ORs) and 95% Confidence Intervals (CIs)—Continued

	Cases	Controls	OR(95% CI)
Medium	29	18	1.5 (.08, 2.8)
High	10	5	1.9 (0.7, 5.8)
P trend	.....	.....	.21
Artwork (using solvents):			
Never[c]	566	571	1.0
Ever[d]	73	65	1.3 (0.9, 1.8)
Low	34	35	1.1 (0.7, 1.8)
Medium	28	27	1.2 (0.7, 2.0)
High	11	3	4.1 (1.1, 15.1)
P trend	.....	.....	.07
Furniture stripping:			
Never[c]	574	579	1.0
Ever[d]	65	59	1.1 (0.8, 1.6)
Low	32	35	0.9 (0.6, 1.5)
Medium	24	14	1.8 (0.9, 3.6)
High	8	8	1.0 (0.4, 2.7)
P trend	.....	.....	.33
Household maintenance			
Auto/truck maintenance:			
Never[c]	378	383	1.0
Ever[d]	260	255	0.9 (0.7, 1.2)
Low	121	129	0.9 (0.7, 1.2)
Medium	107	107	0.9 (0.6, 1.2
High	31	19	1.5 (0.8, 2.7)
P trend	.....	.....	.91
Electronic repair:			
Never[c]	604	612	1.0
Ever[d]	35	25	1.4 (0.8, 2.4)
Low	20	14	1.5 (0.7, 3.0)
Medium	13	5	2.7 (1.0, 7.7)
High	2	6	0.3 (0.1, 1.5)
P trend	.....	.....	.50

[a] Frequency refers to occasions per moth: "low" is less than once a month, "medium" is 1 to 4 times a month, and "high" is more than 4 times a month.
[b] Adjusted for child's age at the reference date, sex, household income at the reference date, and maternal education.
[c] Referent category.
[d] Not all respondents reporting participation specified frequency.

TABLE 3.—Distribution of Cases and Controls by Indoor House Painting in Subject's Home During Year Before Birth, With Odds Ratios[a] (ORs) and 95% Confidence Intervals (CIs)

	Cases	Controls	OR	95% CI
Ever painted:				
No	346	359	1.0	
Yes	289	278	1.2	0.9, 1.5
No. of rooms painted:				
Never painted	346	359	1.0	
1–2	161	188	1.0	0.8, 1.3
3–4	62	48	1.4	0.9, 2.1
>4	64	40	1.7	1.1, 2.7
P trend	.....	.....	.01	
Family stayed at home overnight:[b]				
Never painted	346	359	1.0	
Not at home	25	17	2.3	0.6, 8.9
At home	102	109	1.9	0.6, 6.4
Painter:				
Never painted	346	359	1.0	
Mother	160	152	1.1	0.9, 1.5
Other	128	124	1.3	0.9, 1.7

Note. Not all respondents who reported painting provided information about the number of rooms painted, whether family stayed at home overnight, or who performed the painting.

[a] Adjusted for child's age at the reference date, sex, household income at the reference date, maternal education, and painting during other periods.

[b] Also adjusted for number of rooms painted.

Exposure From Household Painting

We observed no significant overall increase in risk (OR=1.2; 95 percent CI=0.9, 1.5) of childhood ALL associated with interior house painting during the 12 months before the subject's birth, although the risk was elevated among children whose mothers lived in homes in which more than 4 rooms were painted during this period (Table 3). Risk of ALL was not higher among children whose mothers, rather than other people, did the painting (Table 3).

When risk was analyzed by 3-month periods in the year before birth, we also found no significant risk during each period except for a small borderline risk in the 3 months before conception (data not shown). However, when the study population was analyzed by length of time from diagnosis to interview, this association appeared to be due to responses from those interviewed at a more distant time from the reference date.

Among children residing in homes painted after the subject's birth, a small, but borderline significant, excess risk was seen (OR=1.3; 95 percent CI=1.0, 1.6). Risk was elevated for painting more rooms (for >4 rooms, OR= 1.6; 95 percent CI=1.2,2.2) and painting more frequently (for >5 times, OR=1.8; 95 percent CI=1.1, 2.8). When the associations among those interviewed close to the diagnosis date were examined, risk remained about the same, but those associations disappeared among subjects interviewed later.

DISCUSSION

This study found elevated risks for childhood ALL associated with substantial postnatal exposure to some household activities and prebirth and postnatal exposure to indoor house painting. There are, however, several limitations to this study. As in any retrospective interview study, exposures are likely to be misclassified owing both to imperfect respondent recollections and to the crudeness of the information requested. The questionnaire obtained only limited information on the child's proximity to the activity and none on other activities that may involve solvents, particularly home renovation, such as floor refinishing. Moreover, little is known about the relevant time frame for exposure—whether exposures occurred before conception (germ cell mutations), during pregnancy (transplacental fetal exposure), or after birth. With the exception of house painting, the survey was restricted to postnatal exposures.

Our greatest concern in interpreting the findings is the possibility that differential reporting errors by case and control mothers exaggerated estimates of effect.[12] The weaker association with house painting before conception among mothers interviewed near the reference date substantially weakens the credibility of an association with preconception painting. However, the consistency between the other odds ratios and those limited to mothers interviewed close to the reference date supports the findings. Unfortunately, the disproportionate delay in interviewing control mothers limited our ability to check the consistency of associations at interview times very close to the events in question.

Selection bias due to differential socioeconomic status potentially could have resulted from use of random-digit dialing for control selection. Family income, however, was not associated with substantial participation in model building, artwork using solvents, or furniture stripping. Moreover, indoor house painting was more common among high-income controls, which suggests that a selection bias could have underestimated the association with house painting. Finally, socioeconomic factors do not appear to have confounded the relationship between ALL and the activities assessed, because controlling for family income and maternal education did not appreciably affect the results.

Despite the study limitations, there are several arguments for the plausibility of the findings. Some epidemiologic studies have shown an association between paternal occupational exposure to organic solvents and childhood leukemia in the postnatal period.[2,3,10] Exposure of children could occur through inhalation of solvents used at home or brought home from the workplace on the parents' breath.[19] Previous epidemiologic studies have found positive associations between childhood leukemia and painting on the job during the prenatal [7,10,20] and postnatal [10] periods.

Each of the activities associated with an elevated risk of childhood ALL involves exposure to organic solvents, some of which are known or possible human carcinogens. Benzene, a typical constituent in hobby glues in model building[11] and in paints,[12] is an established adult leukemogenic solvent.[21] There is a case report of childhood leukemia following intense exposure to toluene-containing glues used in

model building.[22] Methylene chloride, the main constituent of furniture strippers,[13] is also a possible carcinogen,[23] and trichloroethylene, which may be found in paints and varnishes,[24] has been found to cause cancer in animals.[23]

As the first large case—control study of childhood ALL evaluating associations with hobbies and household activities that may involve carcinogenic solvent exposures, our study is primarily exploratory. Because of the number of exposures examined, confirmation is required to rule out false-positive results. Further study is also warranted of additional household activities involving solvents, with exposure information for individual chemicals and levels and better delineation of specific time frames of exposure (prenatal vs. exclusively postnatal) to illuminate the relevant biological pathways.

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The study was approved by the National Cancer Institute Special Studies Institutional Review Board and obtained the consent of participants.

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STATEMENT OF MARY GUINAN, MD., PH.D., NEVADA STATE HEALTH OFFICER

INTRODUCTION

I am Dr. Mary Guinan, Nevada State Health Officer. I have been asked to speak today on the status of the continuing investigation and Federal agency roles in the investigation of cancer clusters.

Status of Investigation

An Expert Panel was convened on February 15, 2001 to guide the next steps of the investigation. The panel made the following recommendations:

1. *Expand case-finding efforts.*—In progress with Navy. Health Division continues to review cases of leukemia, cancer and other bone marrow diseases reported to us. All reports are kept on file. Expansion of search through the Children's Oncology group and California Cancer Registry will proceed when funding becomes available. (Chronic disease epidemiologist, part time pediatric oncologist).

2. *Categorize the Acute Lymphocytic Leukemia (ALL) cases by clinically relevant biomarkers.*—Need services of pediatric oncologist and funding for locating tissue and determining what phenotypic and genetic tests need to be done and identify laboratory to do testing.

3. *Identify potential excess environmental exposures unique to the community.*—Test the drinking water of case families whose water supply is from private wells. Health Division is in process of testing. Nevada State Health Division has requested assistance from the Centers for Disease Control and Prevention and the Agency for Toxic Substances and Disease Registry Human. Representatives of these Agencies will be coming to Nevada during the week of April 16th to review next steps on the following issues: (a) Collection of blood and urine samples from cases and family members for testing for environmental chemicals, (b) Advisability of dust studies from homes of affected families for environmental chemicals, (c) Environmental pathways assessment, (d) Radiologic assessment of milk produced in Churchill County.

4. *Collect and Bank Biologic Samples for Future Study.*—On hold until funding is made available and storage sites located.

5. *Determine time course and characteristics of population movement into the Fallon area.*—This is part of a bigger picture to provide evidence for population mixing theory. Although some efforts have begun, this is much larger research study than State can support. Federal funding should be made available for this research.

6. *Maintain Expert Panel.*—Panel members have agreed to continue in an advisory role.

In addition the State Health Division has: (a) Enhanced access to public information about the ALL cluster and environmental concerns through multiple public community meetings in Fallon, the Health Division website (health2K.state.nv.us) and a dedicated call-in telephone line. (b) Developed with the Division of Mental Health a mental health crises counseling and community assistance initiative. This has received funding from the Nevada Emergency Management Division and the first steps have been implemented.

LESSONS LEARNED FROM INVESTIGATION OF CLUSTER OF ALL WITH REGARD TO FEDERAL AGENCIES ROLE

1. *Investigation of Cancer Clusters.*—Although hundreds of cancer clusters have been recognized and investigated during the past 30 years by State and local health departments and Federal agencies, little information is available on appropriate scientific methods of study especially with regard to determining causative factors or associated risk factors. Well over 90 percent of these investigations have found no associated suspect causative factor. No Federal agency wants to expend scarce resources in investigation of cancer clusters that are likely to show nothing. However State (or local) health departments must investigate clusters to ensure that a dangerous environmental agent is not present in the community contributing to the increase in cancer cases.

While several Federal agencies have expertise in some part of cancer cluster investigations, no one agency has a comprehensive mandate. We have identified gaps in information available to States as follows:

1. No repository of information exists on the occurrence of cancer clusters (i.e., surveillance of cancer of clusters) or to record the results of these investigations.

2. Lack of a standard or a "best-practices guidance" for the investigation of cancer clusters.

3. No information to identify characteristics of clusters that might be most productive to investigate.

4. No resources available to State to implement investigations of clusters with the most promise of advancing the science of cancer causation.

Bringing together all the relevant Federal Public Health Agencies (National Cancer Institute, Centers for Disease Control and Prevention, Agency for Toxic Substances and Disease Registry) and Environmental agencies to develop a comprehensive approach to the study of cancer clusters (which would include at minimum the 4 activities listed above) would greatly enhance the speed, efficiency and scientific validity of cluster investigations. A guidance for best practices for investigation of clusters would reassure the community that standards do exist for these investigations and that health departments efforts can be evaluated in comparison to the standard. Recognition of clusters that may be most productive in finding evidence for causation of cancer and providing resources for the appropriate study of such clusters would prevent lost opportunities and maximize the probability of advancing the science of cancer causation.

2. *Environmental Factors.*—The cause or causes of acute lymphocytic leukemia are largely unknown. Theories of causation have focused on two main theories, (a) environmental agents such as chemicals or radiation or (b) infection with a virus or bacteria that results in genetic damage that eventually causes leukemia. Studies

of suspect infectious and environmental agents for the most part have not been fruitful.

What the environmental factors should be monitored by health departments in a systematic way? No consensus exists on the minimum standards for environmental surveillance. It would be of immense value to the States if all the involved Federal agencies could be brought together (perhaps by ASTHO, an organization of State health officials or another non-governmental agency) and come to consensus on what constitutes the minimum standard for environmental surveillance for State health departments.

The Environmental Protection Agency is often in conflict with Federal Public Health Agencies on assessment of risks to health of environmental contaminants. This results in a bizarre mixture of conflicting standards for which States are held accountable. EPA should be required to work with Federal Public Health agencies to resolve conflicts on interpretation of scientific data before implementing regulations for the States.

In the Churchill County area many environmental agents are present that may constitute a risk for health, including excess arsenic in the drinking water supply. A great deal of information is available about arsenic in the water and steps have been taken by the city of Fallon to reduce the arsenic in the municipal drinking water. However, community concerns have surfaced about other agents in the environment for which we have much less information. These include jet fuel from Naval Air Station, radioactive substances that may resulted from nuclear testing that was done in 1963 about 20 miles away from Fallon (Project Shoal conducted by Department of Energy), pesticides used for insect control and agriculture, chemical pollutants from industries in the area and air contamination with radioactive or chemical debris from the Sierra Army Depot in California which is about 3 miles from the Nevada border. One of the requirements for the explosion or burning of munitions at this depot is that the wind is blowing toward Nevada at a certain speed before the explosions can take place. There has been no monitoring of the contamination of the air that blows into Nevada from the depot. Therefore no data are available on this potential source of environmental contamination. Despite numerous requests the Environmental Protection Agency has not required California to be accountable to Nevada to ensure that toxic substances are not blown into Nevada from the operation of this depot.

Like all States Nevada does not have jurisdiction over private well water used for drinking water, nor does any Federal agency. The safety of drinking water from these wells is unknown. Churchill County has many households whose water supply comes from private wells. How to ensure the safety of drinking water from private wells is a critical issue for all States. Federal agencies may have a role in providing guidance on solutions to this public health issue.

3. *Community Mental Health.*—Recognition of a cancer cluster in a community is associated with increased stress for the community. The need for preventive mental health services must be assessed. The Nevada Health Division and Mental Health Division have partnered to begin a community mental health initiative in Fallon to assess the need for and to provide the necessary mental health services for the affected families and the community at-large.

It would be of great value to have a model for providing such services for communities experiencing cancer clusters. The National Institute for Mental Health and other Public Health agencies have a role in providing guidance for determining mental health needs and providing resources for these services during crises.

ATTACHMENT

Review and Recommendations of the Expert Panel

The expert panel was convened on February 15, 2001 in Reno, Nevada by Dr. Mary Guinan, Nevada State Health Officer. The panel reviewed the State health department's investigation of acute lymphoblastic leukemia (ALL) cases that had been diagnosed in Churchill County, Nevada. The panel considered possible followup actions and priorities by the Nevada Health Division. The meeting of the expert panel was attended by panel members and staff from the Nevada Health Division, University of Nevada School of Medicine, Nevada Governor's Office, U.S. Senate (Senator John Ensign's Office and Senator Reid's staff on U.S. Senate Committee on Environment and Natural Resources), and the Fallon Naval Air Base. This report summarizes the panel's review and recommendations.

The expert panel recognized the difficulty in evaluating and investigating excess occurrences of ALL. The panel members acknowledged that the cause(s) of ALL are

insufficiently understood to single out a specific factor as explaining the observed excess in Fallon, Nevada. The panel members were familiar with previous investigations of ALL clusters, all of which had failed to uncover an explanation of the cause of these excesses. At the same time, the panel members confirmed that the excess occurrence of ALL in Fallon, Nevada is unusual; not only because of it's large number of observed cases among so small a population-at-risk over a short time period, but also because further observed ALL cases had been diagnosed after the initial recognition of the ALL excess. The members of the expert panel acknowledged the excellent work of the staff of the Nevada Health Division on this investigation.

Scientific understanding of the biology of ALL prevented the committee members from predicting the cause of the observed excess of cases in Fallon. The committee is aware of at least three distinct sets of possibilities. The first set of theories collectively point toward a cancer causing chemical contaminant (e.g., human carcinogen) as the causal agent for the ALL epidemic. Theories about a chemical in the environment have received the greatest amount of public attention and community concern. The expert panel recognizes the need to address community concern regarding the presence of a hazardous chemical contaminant. However, the absence of cases of acute myeloid leukemia, the type of leukemia most commonly associated with toxic chemical exposure (1–3), argues against the Fallon cases being the result of toxic exposures. The panel members were skeptical that a chemical exposure could explain the excess cases of ALL in Fallon, Nevada. A second possible explanation relates to the theory of what is called population mixing in which clusters of ALL have been reported associated with unusual mixing of people, often in relatively isolated rural areas (4–11). The population mixing theory initially focused on the possibility of an unidentified infectious agent (i.e., a virus). However, the current consensus is that exposure to a variety of infectious agents (i.e., viral and bacterial) may trigger an unusual and rare reaction that affects a very small number of children within the susceptible population. The hypothesis suggests that ALL is not infectious, spreading from one person to another; but an unusual complication to a common infection within a susceptible population. The population-mixing theory is supported by the observation that excesses of ALL eventually subside, presumably because of increased population immunity. This theory requires further examination. The panel believes it reasonable to test this hypothesis by calculating rates of ALL in other rural areas of the U.S. having significant population mixing. However, such an effort falls outside the mandate of the Nevada Health Division. Finally, the possibility that the excess of ALL cases is due to random chance cannot be totally excluded as an explanation. The panel acknowledges, however, that the excess of ALL cases in Fallon, Nevada is not likely to represent a "chance" occurrence.

The expert panel recommends to the Nevada Health Division six followup steps in the investigation of the excess occurrence of ALL in Fallon, Nevada (see Table 1).

The purpose of these next steps are to: (1) efficiently expand case-finding efforts, (2) categorize the observed ALL cases by clinically relevant disease biomarkers, (3) identify potential excess environmental exposures unique to the community by a cross-sectional exposure assessment of selective contaminants and an evaluation of contaminant releases into the local environment with assessment of completed pathways for the case families, (4) collect and bank biologic specimens for future scientific investigations, (5) determine the time course and characteristics of population movements into the Fallon area for the period 1990 to 2000, and (6) maintain an expert panel to peer review investigative protocols and study results, consider future use of banked specimens, and provide ongoing consultation to the Nevada Health Division.

The expert panel also discussed the importance of high concentrations of arsenic in municipal and private drinking water supplies. The panel members expressed doubt that arsenic consumption in drinking water, by itself, could explain the observed ALL excess for several reasons: (1) The excess occurrence of ALL began in 1999, whereas the arsenic concentrations in drinking water have been consistently elevated for many years. (2) The case children who make-up the excess occurrence of ALL differ in respect to their consumption of arsenic contaminated drinking water. (3) Epidemiologic studies of arsenic exposed populations have not linked arsenic exposure with adult or childhood leukemia. One recent article suggests a weak association between childhood leukemia risk and exposure to low levels of arsenic in drinking water (12). The panel has reviewed the article and believes that the study is inadequate to support a conclusion that ALL is related to arsenic in drinking water. Each panel members expressed concern that the ongoing exposure to excess levels of arsenic in drinking water was a human health hazard, regardless of its relationship to the excess of ALL. The Fallon municipal water supply is contaminated with arsenic (As) at a level 10 times the EPA recommended standard for ar-

senic in drinking water. The panel was also aware that an unknown proportion of Churchill County drinking water wells, unregulated by the Federal Safe Drinking Water Act (SDWA), are at least as contaminated as the Fallon municipal water supply. Arsenic is recognized by the Report on Carcinogens of the National Toxicology Program as a known human carcinogen on the basis of epidemiologic studies that have linked arsenic exposure with an excess of skin, bladder, and lung cancers in exposed human populations.

The expert panel recommends that arsenic concentrations in the Fallon municipal drinking water be reduced to a level no more than that currently recommended by EPA (e.g.; 10 μg/L) as soon as possible. The panel strongly encourages the Nevada Health Division, and other State agencies, to proceed with recommendations for testing arsenic in all drinking water wells in Churchill County that are unregulated by the SDWA. The State health division should work to create a process providing this service when necessary and develop a set of recommendations for preventing arsenic exposure based on reported test results. The State health division should consider maintaining a listing of wells that have been tested along with test results.

Table 1: Investigating the excess occurrence of Acute Lymphoblastic Leukemia in Fallon, Nevada: Phase II Recommendations of the Expert Panel (February 15, 2001)

Priority Task/Timeframe/Collaborators

1. Efficiently expand case-finding efforts. The panel members encourage the Nevada Health Division to continue limited case-finding strategies. The panel members recommended limited expansion of case-finding by linking to:

A. The national Childhood Oncology Group (COG) data bases(s) to identify all children with ALL having a residence at time of diagnosis in the State of Nevada. The purpose of this would be to evaluate completeness of the Nevada tumor registry and identify additional ALL cases from Churchill County.

B. An ongoing case-control study of ALL being conducted in California to review residential history of cases for previous residence in Churchill County, Nevada.

C. The California State Tumor Registry to identify any children with ALL with a Nevada residence at time of diagnosis.

Timeframe.—These additional steps could be done within 2 months after satisfactory negotiations regarding patient confidentiality are completed.

Potential Collaborators.—Clinical Oncology Group, California Tumor Registry, California ALL research team.

2. Categorize the observed ALL cases by clinically relevant disease biomarkers. Cancer cells from each case-child have probably been collected and undergone immunophenotyping and cytogenetic testing. The health division should collect this information. If testing has not been done and tumor cells have been stored, the health division should secure samples and have them tested. These materials could be reviewed or tested at two independent laboratories. The distribution of these results among the case-children from Fallon can be compared against other children with ALL to determine if these distributions are similar or if the distribution among the Fallon case-series is unique.

Timeframe.—The health division should proceed to determine availability of data or tumor cells as soon as possible.

Potential Collaborators.—Pediatric oncologists, Childhood Oncology Group, National Cancer Institute.

3. Identify potential excess environmental exposures unique to the community. The health division should conduct limited testing for *current* exposures in environmental media or human samples as well as evaluate contaminant releases into the local environment and assess the potential for human exposure to such contaminants. This analysis would be used to identify chemicals that are (and are not) elevated in the community and to consider if additional data collection is required.

A. A cross-sectional exposure assessment of selective contaminants would include examination of drinking water, human blood and urine of family members, and possibly dust collected from homes where case-children did and did not live. Testing should be limited to compounds for which normative data are available. The expert panel recommended testing for volatile organic compounds in drinking water and human tissues; radioactive isotopes in drinking water; selected heavy metals in drinking water, household dust, and human tissues; and pesticides in human tissues and in household dust.

B. An evaluation of contaminant releases into the local environment with assessment of completed pathways for the case families. The expert panel recommends collecting environmental release data, including that from local industry and the Fallon Naval Air Station. An assessment of the potential for environmentally released chemicals to result in human exposure should also be conducted, including potential for case-children to have been exposed.

Timeframe.—These activities will require development of survey and sampling protocols and appropriate review of consent forms and confidentiality agreements. The committee anticipates startup of these activities during the months of March or April and available results within 1 year.

Potential Collaborators.—National Center for Environmental Health, Centers for Disease Control and Prevention; Agency for Toxic Substances and Disease Registries; Jonathan Buckley (University of Southern California) for input on measuring housedust for pesticide residues, heavy metals, PAHs. .

4. Collect and bank biologic specimens for future scientific investigations. The members of the panel recognize how limited our knowledge is of the cause(s) of ALL and the difficulty investigators have had in identifying the causes of similar ALL excesses. The panel members believe that collection of biologic specimens from case-children and family members may be useful for future research investigations into the cause(s) of ALL. A small amount of blood and urine, and perhaps buccal cells, should be collected, maintained, and made available for future research.

Timeframe.—Collection of specimens could occur simultaneously with the exposure assessment (see 3A) or include samples taken during clinical care. A protocol for collection, storage, and access to samples must be developed and reviewed by an Institutional Review Board for compliance with human subject research.

Potential Collaborators.—Nevada Public Health Laboratory, National Center for Environmental Health, Centers for Disease Control and Prevention, National Cancer Institute as possible repositories for the tissue bank.

5. Determine the time course and characteristics of population movement into the Fallon area for the period 1990–2000. The expert panel recommends collecting demographic data concerning changes in the population of Fallon, specifically looking for evidence of large migration of new long-term residents into the community during this time period. The appended table illustrates the kind of first-level information that is relevant to this issue.

Timeframe.—Initial data collection within 2 months.

Potential Collaborators.—Public school systems and Fallon Naval Airbase (for information concerning migration patterns), Drs. Les Robison and Malcolm Smith (for consultation to identify the specific data required).

6. Maintain the expert panel to peer review investigative protocols and study results, review proposals for future use of banked specimens, and provide ongoing consultation to the Nevada Health Division.

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STATEMENT OF RANDALL TODD, STATE EPIDEMIOLOGIST, NEVADA STATE HEALTH DIVISION

Good morning Mr. Chairman and members of the committee. For the record my name is Dr. Randall Todd. I am the Nevada State Epidemiologist and work for the Nevada State Health Division. I would like to briefly describe the Health Division's investigation into the cluster of childhood leukemia in Churchill County and discuss the role of Nevada's Central Cancer Registry.

The initial phase of our investigation consisted of confirming the diagnosis of each reported case and conducting an interview with each case family to identify any potentially common characteristics or environmental exposures that might point to a preventable cause. We are indebted to the Centers for Disease Control and Prevention as well as the Massachusetts Department of Public Health for their assistance in providing us with model interview instruments.

The case family interviews were conducted face-to-face with each family. This involved a detailed review of the family's residential history from the date of diagnosis back to a point in time 2 years prior to conception of the ill child. For each residence we inquired as to the source of water, in-home treatment of water, and uses of water. We also inquired about known exposures to chemicals from agricultural or home use of herbicides and pesticides as well as indoor uses of chemicals and solvents. For each parent, we also inquired about occupation and occupation-related exposures to chemicals, fumes, dust, or radiation. We conducted a detailed review of the child's medical history and the mother's pregnancy and breast-feeding histories. Finally, we asked case families about any hobbies, sports activities, or typical travel destinations that might have brought them into contact with chemicals, fumes, dust, or radiation.

From this interview process we learned that half of the case families had spent 2 years or more in the Fallon/Churchill County area. The others had resided in the area for shorter periods of time. The 12 case families had resided in a total of 88 different homes over their respective time periods of interest. Of these, 22 were located within Churchill County. Of these 22 local residences, half were served by public water systems while the others obtained their water from domestic wells.

Our initial analysis of the occupational, medical, environmental, and other historical information provided by the case families has not suggested any particular common denominator that would link these cases together. We recognize, however, that some of our data is subject to recall limitations on the part of the families. Specifically, they may not have known of an environmental exposure that did, in fact, exist, or may have forgotten about it. For this reason we are currently taking steps to obtain additional data through objective environmental sampling. This constitutes a second phase of the investigation.

We are now in the process of obtaining water samples from those current and former case residences in Churchill County that are served by domestic wells. These samples are being subjected to the analyses that are routinely done for public water systems. In other words, any test required by the safe drinking water act for public water systems is also being conducted on the water samples obtained from the wells of residences where case families have lived. The results of these analyses are pending at this time.

We have also invited the Centers for Disease Control and Prevention as well as the Agency for Toxic Substances and Disease Registry to assist us in identifying and analyzing completed pathways for other sources of environmental contamination. This would include industrial, agricultural, military, or other sources.

On a parallel tract with these environmental studies we are also collecting data on the overall population dynamics in Churchill County. This includes looking at size of various age cohorts over the last 10 years, school enrollment information, and military populations. This analysis will help to determine if Churchill County matches the profile of other communities around the world where population mixing has been suggested as a possible explanation for increased rates of childhood leukemia.

In closing, I would like to make some brief comments as to the importance of cancer registries in the conduct of cancer cluster investigations. Nevada has maintained

a population-based cancer registry since 1979. This activity has been funded, in part, through a grant from the Centers for Disease Control and Prevention since 1995.

All disease reporting systems, including cancer registries, experience a lag in time between the diagnosis of a case and the reporting of that case. With a disease such as cancer, the patient record may not be complete enough to warrant abstracting information until about 6 months from the date of diagnosis. Additional delays in obtaining information beyond this 6-month time period relate to work load and staffing. In the more rural parts of Nevada, this situation is made even more difficult due to the distances involved and the relatively low number of acute hospital beds in each facility making it a costly and time consuming process to collect rural data. For these reasons, if a cancer cluster is identified through a cancer registry it is likely to have been going on for some time.

The increased incidence of childhood leukemia in Churchill County was not identified through analysis of cancer registry data. The local hospital, physicians, and community leaders noted the cases and perceived the numbers to be unusually high. Nevertheless, Nevada's cancer registry has been invaluable in helping to place the observed number of childhood leukemia cases in historical and geographic context. Only through analysis of cancer registry data have we been able to calculate the usual rate of childhood leukemia and determine that the local cases represent a significant excess over the expected.

I hope this overview of our investigation to date and the role of cancer registries has been helpful. I would be happy to answer any questions the committee may have.

STATEMENT OF REAR ADMIRAL RICHARD J. NAUGHTON, U.S. NAVY, COMMANDER, NAVAL STRIKE AND AIR WARFARE CENTER

Good Morning. My name is RADM Richard J. Naughton and I am the Commander of the Naval Strike and Air Warfare Center located at Naval Air Station, Fallon, NV. Here with me this morning is CAPT David A. Rogers, the Base Commander. We welcome the opportunity to testify before the Environmental and Public Works Committee on military activity in the Fallon area, particularly as it may pertain to Churchill County's recent childhood Leukemia cluster situation.

I will begin with a short discussion of the mission and operations at Fallon followed by some remarks on items I know are of special interest to the committee members. I will then be happy to entertain questions. Let me assure the committee members that the United States Navy is committed to public health and assisting this continuing investigation in any way possible. One of the cases in question is the child of a military member stationed at Fallon and three fourths of our base population of 7200 personnel and their family members live off base. The Navy's Bureau of Medicine has just completed an extensive screen of Naval Cancer cases which might be related to being stationed at Fallon. Their review of over 12 million records from 1997 to the present revealed just the one Navy case already identified. The Navy is also committed to exploring the Expert Panel's Population Mixing Theory and has shared data on transient activity at NAS Fallon with the State. While further examination of similar demographic data in other military locales (i.e. small isolated communities near military bases with large numbers of transients in training) would appear prudent, it will take a coordinated effort by the entire Department of Defense to conduct such a study.

As many of you know, NAS Fallon has been in operation since 1942. The focus of the base was squadron level air-to-ground combat training until 1984, when the Navy established the Naval Strike Warfare Center ("Strike University") and began focusing on training entire air wings (1500 personnel and 70 aircraft) in an integrated fashion. The mid-eighties also saw the development of the Fallon Range Complex—an instrumented Military Operating Area flown over 6.5 million acres East of Fallon. The majority of the land we fly over is managed by the Bureau of Land Management, as the Navy only directly controls 204,000 acres. The third major change in the mid-eighties was the outsourcing of many of the functions on the base, which is reflected in our current percentage of contractors (55 percent). 1996 saw the consolidation of all graduate level aviation flight programs at Fallon with the arrival of "Topgun" and "Topdome" from Southern California and the establishment of a senior two-star Flag officer on the base as Naval Strike and Air Warfare Center, or NSAWC. As NSAWC, I report directly to the Chief of Naval Operations and provide oversight for training of approximately 55,000 sailors a year. The base has conducted an average of 40,000 flights a year for the past 5 years,

with a 4 to 5 percent increase over that time. The investment in NAS Fallon since 1984 has been almost $300 million dollars.

I would like to discuss some of our specific operating issues as they might pertain to this investigation. First, the consolidation of all of our training here in 1996 did not appreciably change the way we conduct operations. We fly the same aircraft and the number of flights has only increased by 4 to 5 percent. In fact, our two biggest years in terms of flight generation at NAS Fallon occurred in 1990 and 1991 in preparation for Operation's Desert Shield/Storm. The type of flight training NSAWC conducts has remained unchanged, particularly from an environmental perspective.

Second, NAS Fallon's Environmental, Safety, Operations and Weapons Departments are responsible for the administration of all of our environmentally sensitive materials. For anything we use, there's a program for safely handling and disposing of it where applicable. We follow guidelines established by Federal, State, Department of Defense and the U.S. Navy and arguably more heavily regulated than the private sector. Programs such as Fuel Handling, Air Emissions, Hazardous Materials Disposal, Electromagnetic Radiation Effects and Installation Restoration are all inspected on a regular basis and have received high marks for compliance. We have shared the details of each program with the State Health Division and Expert Panel and are prepared to do the same with the Agency for Toxic Substances and Disease Registry when they visit next week.

Third, NAS Fallon's drinking water supply services the 3000 personnel who work on the base and up to 2000 transients at any one time. It is separate from the city of Fallon's but taps the same Basalt Aquifer with the resultant water chemistry being identical. The base tests our water supply routinely and also monitors for contamination of the 8000 acres of base property through the use of 218 environmental monitoring wells. No DoD activity-related contaminants have ever been detected in the Basalt aquifer or leaving base property. While the State and Select Panel investigations have not established a link between Fallon water arsenic levels and the Leukemia cluster, these levels are a matter of concern to the Navy. We are working on a joint DoD/city of Fallon water treatment facility.

My detailed written statement previously submitted for the record contains further information on NAS Fallon activity as it might relate to this investigation. It also lists points of contact for additional information if required. Thank you for your attention. I will now entertain any questions.

STATEMENT OF RADM RICHARD J. NAUGHTON, USN COMMANDER, NAVAL STRIKE AND AIR WARFARE CENTER AND CAPT DAVID A. ROGERS, USN COMMANDING OFFICER, NAS FALLON 12

The following paragraphs are designed to provide the reader with background on operational activity at NAS Fallon, NV as it relates to the environment in general and the leukemia cluster in specific. The Navy is committed to public health and will assist the State-led investigation in any way desired. Specific points of contact are listed for further detail if required.

1. MILITARY TRAINING ACTIVITY AT FALLON WITH POSSIBLE ENVIRONMENTAL CONSEQUENCES

A. Fuels

1. NAS Fallon's fuel is supplied by the Kinder-Morgan Company of Sparks, NV, through a 70-mile pipeline. The pipeline is cathodically protected with induced current and monitored. It is also visually inspected by air weekly, visually inspected by truck bi-weekly and kept under pressure even when fuel is not being pumped so as to monitor for leakage. No leaks have ever been detected. The point of contact at Kinder-Morgan is Mr. Girard Gonyeau at 775–358–6971.

2. *Spills.*—The Nevada Division of Environmental Protection strictly regulates fuel spills. There are reporting requirements for spills over 25 gallons, spills that contaminate three cubic yards of soil, or spills of any amount that contaminate surface water.

3. More than 95 percent of fuel spills are confined to paved areas on the flightline, runways or taxiways. The average spill is about 15 gallons, and there have been an average of 60 of those per year over the last 10 years. Spills on paved areas are cleaned-up immediately using absorbent pads or absorbent media. Spills on soil are cleaned by excavating and subsequent proper disposal of the contaminated soil. These procedures and amount of spillage are similar to procedures and amounts at any commercial airport with a similar operating tempo.

4. The largest spill in the last 5 years was approximately 400 gallons. The spill resulted from a break in an underground fuel delivery pipeline. All soil contami-

nated by the spill was excavated and transported to an authorized treatment facility near Mustang, NV.

5. *Fuel venting.*—This is also heavily regulated. We must report all incidents and must vent fuel above 6000 feet above ground level. Above 6000 feet, 99 percent of fuel is vaporized. Fuel may be vented/jettisoned below 6000 feet only in an actual aircraft emergency. The last 15 years worth of data show an average yearly vent of 3.5 occurrences above 6000 feet (1500 gallons total). There have been three occurrences in 15 years where fuel was vented below 6000 feet (800 gallons total)—each was east of the base on BLM property and nowhere near population centers (the nearest settlement East/Southeast of the base is Middlegate Station located 32 miles East/Southeast.

6. *Aircraft mishaps (crashes).*—Of the 12 mishaps in the last 15 years, nine were in the operating area on BLM land or on Navy property, the remaining three were on private property. Ten of 12 had fire associated with the crash that consumed residual fuel. State Health department personnel have determined that there were no long term environmental impacts from any of those events.

B. Air Emissions

(1) NAS Fallon has just completed an extensive modeling effort for base air emissions endorsed by the State Environmental Division. The modeling shows that NAS Fallon meets all Nevada ambient air quality standards.

(2) The base has many detailed reports on the composition of jet exhaust, which varies by type of aircraft. Each of these is monitored by the Nevada Division of Environmental Protection and United States Environmental Protection Agency to assure public safety. While the quantities of materials released into the atmosphere vary according to aircraft type, they essentially involve a mix of the following five: Carbon Monoxide, Nitrogen Oxide, Sulfur Oxide, Hydrocarbons and Particulate Matter, each of which are relatively common at most industrial sites, particularly airports. The total amount of all contaminants released into the atmosphere equates to 1500 parts per million per day at an average operating tempo (115 flights per day). This equates to approximately half that of the Reno-Tahoe International Airport. Commercial "Jet-A" fuel is composed of the same basic materials and burns in an almost identical fashion to that of military "JP–8", the primary difference being the addition of an anti-icing agent in JP–8.

(3) The fire department open burns approximately 30,000 gallons of jet fuel per year in training permitted under the Nevada Division of Environmental Protection Bureau of Air Quality. The fuel is burned no more than four times per month and/or two times in any week. When it occurs it is also dependent on the winds, which must be blowing at least five knots from the West to avoid blowing the smoke toward the community. The chemicals contained in fire smoke are roughly twice that contained in jet engine exhausts. The total amount released into the atmosphere equates to 1/1000th of that released by the jet traffic at the airfield. Other fire departments around the country routinely burn fuel for training.

C. Other Hazardous Materials (HAZMAT)

Other HAZMATs (cleaning solvents, paints, pesticides, photo processing, vehicle fluids, etc.) are routinely used on base. An extensive HAZMAT handling facility and program is managed by the NAS Fallon Supply Department with oversight from the Industrial Hygiene Office, the Safety Office, the Environmental Office and the Weapons Department. All hazardous waste generated by station operations is sent to permitted treatment, storage and disposal facilities. Details are available from the NAS Fallon Supply Officer, CDR Troy Brannon, 426–2750, or NAS Fallon Environmental Division Head, Mr. Doug Bonham at 426–2772.

D. Electromagnetic Radiation (EMR) Hazards

(1) A survey of electromagnetic radiation hazard for NAS Fallon is conducted approximately every 3 years by the Department of Defense Inspector General Office. No significant hazards of electromagnetic radiation to personnel situations were detected on the Naval Air Station. The systems used at NAS Fallon include aircraft navigational aids, radar for aircraft and weather, radios, cell phones, electronic warfare (EW) equipment and aircraft. Equipment used at NAS Fallon adhere to the DOD radio frequency safety standards and the Institute of Electrical and Electronics Engineers recommended practice for the measurement of potentially hazardous electromagnetic fields and microwave. (The standard developed by representatives of industry, government agencies, scientific communities and the public.)

(2) Standard operating procedures are used to protect Navy personnel and the public from EMR hazards. These procedures include setting the height and angle of transmission to avoid direct exposure, posting warning signs, activating warning lights when the radar are operational, and/or securing sites with fencing. EMR from

EW systems is the same type as emitted by cell phones, hand-held radios, walkie-talkies, commercial radio, and television stations. EMR from a typical EW site averages less and 0.325 milliwatts per square centimeter; EMR from a cell phone is 1.19 milliwatts per square centimeter. Other sources of EMR include navigation aids and radar. These systems are the same or similar to civilian navigation aids and radars at airports, TV weather stations, and aircraft navigation aids throughout the United States. All systems have safety limits to prevent potential hazard. Measures are also in place to prevent hazards from EMR emitted by military aircraft. The majority of EMR is emitted in the training airspace east of the Naval Air Station.

E. Depleted Uranium (DU) Ammunition.

Depleted uranium is the inert, low-radioactivity uranium which remains after more-radioactive isotopes have been separated from natural uranium or spent reactor fuel. DU is used globally in private industry as radiation shielding, ballast and counterweights in commercial and military aircraft. The U.S. Military continues to use DU projectiles because of their extraordinary effectiveness as anti-armor munitions. Chemically and toxically, DU is no different than the natural uranium found in air, soil and water everywhere on earth. DU ammunition has never been used, nor is it authorized for any of the Fallon ranges.

F. Chaff

(1) Radio Frequency (RF) chaff is a glass fiber substrate with a thin coating of aluminum. Typical chaff rounds contain 200,000 fibers (.001 inches in diameter) and weigh five ounces. Chaff is expended on our ranges east of Fallon to train aircrew on vital defensive countermeasures when encountering enemy surface-to-air missiles. As a chaff bundle is deployed from an aircraft, it "blossoms" to attract or decoy the enemy radar. The fibers will disperse with the prevailing wind.

(2) Historical concerns about chaff have revolved around its potential harm to the environment. In March 2000, an independent study on the environmental effects of RF chaff by a team of research scientists from various universities concluded that existing chaff systems are environmentally benign and not a health hazard. The chemical composition is very similar to that of desert dust. A copy of this report is available from the NSAWC Range Department, LCDR Lynn Tawney at (775) 426–2108.

(3) The total amount of chaff expended on the Fallon ranges amounts to ¼ ounce per acre per year. This amount is several orders of magnitude less than EPA standards for dust, vehicle exhaust, power generation and industry.

2. INSTALLATION RESTORATION (IR) PROGRAM

A site investigation to determine the nature and extent of possible contamination at NAS Fallon was begun in 1988. Past practices had resulted in contamination by fuels such as gasoline, diesel and jet fuel; solvents containing PCE and TCE; and landfills containing garbage, trash, and demolished building materials including asbestos. Fuels and solvents have contaminated the shallow groundwater (between 4′ to 10′ below ground surface) beneath portions of the base. Over 100 wells are systematically sampled to monitor these contaminants and ensure that the contaminants are controlled before they could effect human health or the environment. The program is designed to prevent contaminated groundwater from leaving the base boundary and to date none has.

The city of Fallon and the Paiute-Shoshone Tribe pump drinking water from the deep basalt aquifer near Rattlesnake Hill, over 7 miles northwest of the base. Due to the nature of the groundwater system in the Carson desert and the location of NAS Fallon there is no possibility for the contamination beneath NAS Fallon to reach the drinking water supply used by the City, Navy and the tribe. The closest drinking water wells to the main base boundary belong to the Navy and they are located over 3 miles to the northwest of the base, which, is the southernmost point of the basalt aquifer. The water in the shallow aquifer (ground surface to 50 feet) underlying the base flows to the south away from drinking water supplies. The nearest settlement is 32 miles away.

For questions call John Dirickson at (775) 426–3184.

3. WATER INFORMATION UPDATE

The current EPA arsenic standard is 50 parts per billion (ppb). A new EPA arsenic standard was finalized at 10 ppb in January 2001. The EPA Administrator has announced her intention to review the technical basis for the rule and to extend the effective date for it. NAS Fallon and the city share the same basalt aquifer water source with resultant naturally occurring arsenic levels of 90–110 ppb. An EPA Notice of Violation was issued to NAS Fallon in January 2000 to reduce the

amount of arsenic in the base's drinking water system. In September 2000 the EPA issued an administrative order requiring NAS Fallon to meet at least the current 50 ppb maximum contaminant level for arsenic in drinking water by late 2004. NAS Fallon has three wells that are each approximately 500 feet deep. The water chemistry for the NAS Fallon wells and the city of Fallon wells is essentially the same.

Arsenic treatment is required for the city of Fallon in 2003 and NAS Fallon in 2004. NAS Fallon is conducting pilot studies to select the best treatment technology. A joint NAS/City effort to construct a water treatment facility is under consideration. Interim measures at NAS Fallon consist of:

(1) Free Reverse Osmosis (R.O.) filtered water available at 37 locations on base. All units are tested twice annually to ensure we meet drinking water standards for arsenic (the R.O. units routinely test to less than 1 ppb for arsenic).

(2) Commercial bottled water is available in work spaces and at the Child Development Center.

(3) A free bottled water machine is available 24-hours a day in the Sierra House of the BOQ.

(4) Free water testing can be obtained by military members not living in base housing or on the city water system.

(5) R. O. filtered water systems will be installed in base housing commencing approximately May 1, 2001.

The point of contact for water issues is Mr. Mark Jones (775) 426–2785.

STATEMENT OF KEN TEDFORD, JR., MAYOR, FALLON, NV

Recognizing that my time is brief, let me begin by saying that the city of Fallon sincerely appreciates the efforts of the Senators, Congressman and your staffs—just as we appreciate the work being done by the Governor's Office and the State Health Division. These are trying times for our community and, while we have pulled together in the only way we know how, it is comforting to know that others want to help.

I'm not going to spend any time discussing the cluster's cause, or possible links between the children. I believe the State Health Division and others will cover that. The city has cooperated in every way we know, first as the steward of the municipal water system and later as we have begun to assess other city-owned facilities. Thus far, nothing has been found. We recognize that the Health Division's expert panel believes that an environmental link may not be found, due in part to the fact that the ALL found in this cluster is not typically caused by environmental triggers. Nonetheless, we will continue to cooperate in that search.

Our efforts have been focused on the children, the affected families, and public education. The City Council and I have formed a group called "Fallon Families First", comprised of local community leaders and social service providers, to coordinate these efforts. I asked my wife Jennifer to chair the committee, and they are doing a yeoman's work. Please realize that our city does not have a social service infrastructure. We are too small. So we have had to reach out to groups like the FRIENDS Family Resource Center, the local hospital, mental health professionals, the clergy, the school district, the County and others.

Today there is a single source of assistance for the families, the Family Resource Center. Patient services are coordinated by the Nevada Health Advocates in Carson City, and hopefully soon with the National Leukemia and Lymphoma Society Chapter in Sacramento. Fundraising is handled through the Mayor's Youth Fund. You can see the white ribbons worn by guests here today, a suggestion by a mom of one of the patients. It's the latest step in our effort, and we plan to continue raising funds as long there are needs.

Fallon Families First recently held its first public meeting, a panel discussion focused on the disease itself. Local physicians, a mother of a stricken child, and a mental health professional, who people know and trust, helped answer the questions weighing on the minds of those attending. Efforts like this will continue as they are needed. A series of informational mailings is also being coordinated with the County and the local telephone company. This week the city launched its first Web site. Part of this effort has been driven by the need to communicate about the leukemia cluster, and part by our desire to be generally more accessible.

So what remains to be done?

I can tell you without hesitation that the most frustrating part of this process has been the lack of information. People want answers, and I don't have them. The investigation is ongoing, but it's bound to take a long time. Where do people go for answers? I believe, in cluster situations like this, a clear sense of communication needs to be established early in the process. Perhaps if the State Health Officer de-

clares a cluster to be in existence, that could trigger a Federal/State/local partnership. The mayor's office seems to be the place people automatically go, but in small towns like ours we don't always have the information. I have assembled my own team of local citizens and other experts who can help the city. But in other towns, the mayor might not be so fortunate. I think a standard support team or ombudsman should be made available to towns like ours.

Finally, I would be remiss if I didn't speak briefly about the arsenic in our water. I KNOW the Senators are aware of this situation, just as I know the experts will testify that the arsenic is probably not linked to the leukemia cluster. But the two things have become linked in the media and in earlier meetings, so I feel we owe you at least an update.

Fallon's municipal water supply contains arsenic at levels of 100 parts per billion. The U.S.E.P.A. has ordered us to remove the arsenic, which is naturally occurring here. As you are well aware, the EPA standard has long been under review. It was 50 parts per billion. It was temporarily lowered to 10. Now it is back at 50. We have no idea where it will finally be set. For the city of Fallon it doesn't matter any more.

The city of Fallon, through its environmental engineering firm Shepherd-Miller, has begun pilot testing the technology we will use to remove the arsenic. It appears that a process called "enhanced coagulation" is working best. We will finish the pilot testing by the end of May. Then we will design and site a treatment facility. Our goal is to have construction finished in time to comply with the EPA order, which gives Fallon until September 2003. This date is significantly earlier than any other public water system, and it's still not clear how much arsenic we will have to remove. Nonetheless, we are proceeding. And we are doing so without regard to costs, or where the money will come from. We have also been in consultation with U.S. Navy officials about a joint plant.

My suggestion to this body today is that you make Fallon a test case. The issue of the EPA standards revolves around "best available science" and the fact that there is no "off the shelf" technology to remove arsenic on a municipal scale. Things like household reverse osmosis systems won't work on the scale we're talking about here. We believe that since Fallon is required to remove its arsenic more quickly than other municipalities, there may be benefits to those who follow from learning from what we do. Perhaps the Federal Government could pay for the cost of Fallon's treatment facility, in exchange for the availability of the science and treatment methods resulting here that can be utilized by all those who follow.

We're dedicated to treating city water. Others will have to address the many private county wells that have high arsenic levels. And all of us will have to respond to public education issues and outside media attention that now surround the arsenic. But with your help, we can put this chapter in our history behind us and focus all our energies on the leukemia cluster, the children and their families.

We must maintain our focus on these families. As I said earlier, this is a lonely time for our town. Many people want to speculate, many others are well intentioned in their scrutiny. Others are just curious. But when the camera lights are off and the media attention fades, our town will be left to care for our children and assess the long-term impacts of this unusual cluster. Your presence here today is a chance to change that. I hope you will be able to stick with us, and I thank you for taking the time to come here today.

STATEMENT OF GWEN WASHBURN, CHAIRMAN, CHURCHILL COUNTY COMMISSION

Good morning, Honorable Senators. First, as Chairman of the County Commission, I want to tell you that the County Administration is first and foremost concerned about the health and well being of the people. I am happy to have the opportunity this morning to address the issue of the leukemia cluster identified in this community, and to discuss ways to investigate and mitigate the problem. I will give you a little information about Churchill County and what the County Commission is doing at this time.

Churchill County has sustained a steady growth of about 3 percent over the years and now is home to about 26,000 people. The population is expected to double in the next 15 years. We are a progressive small community, boasting modern schools, a community college, an arts center and the most modern hospital in western Nevada. We have a mix of long time agricultural-oriented families, military personnel, young working families and retired people. Many people are born and grow old here with nothing more than average health problems, so the community is alarmed and feels helpless in the face of a childhood leukemia epidemic.

The community has reacted to this crisis in a quick and calm manner, working cooperatively together with all agencies in an attempt to find any answer or com-

mon link between the cases. The County Commission is very concerned about the health and welfare of not only our 26,000 residents, but also those that visit us each year as military personnel or tourists. Certainly, none of us are experts in the health field, nor are we research scientists. We have no choice but to leave the investigations to the experts. What we can do, have done, and will continue to do is support all scientific and responsible efforts to find an answer.

We have actively participated in Governor Guinn's investigation and in Assemblywoman de Braga's investigation. We joined forces with the city of Fallon and Churchill Community Hospital in development and distribution of a fact sheet (Attachment #1) that attempts to answer the most commonly asked questions about leukemia and what the community is doing about it. We also support Mayor Tedford and the Community Hospital in their individual efforts to assist the families of the victims with the Fallon Families First organization, and the health information center.

I, personally, have spent many hours in consultation with personnel of the University of Nevada, Reno, Extension Service to update and reactivate a drinking water safety program known as Nevada GOLD (Guard Our Local Drinking water). The University responded favorably and quickly by hiring a research specialist to locate and correlate all existing water studies in an attempt to find any possible cause of cancers in our local (outside the city of Fallon) shallow wells. Studies have shown that water from the shallow aquifer is variable and may contain Magnesium, Sulfates, Chloride, Nitrates, Fluoride, Arsenic, Iron, Manganese and other minerals above levels recommended by EPA. (Attachment #2) Nevada GOLD is also teamed with the local hospital to provide water sample bottles, instructions and transportation of water samples to the State Health Laboratory giving all well owners the opportunity to have their water tested for bacteria and heavy metals. (Attachments #3–7). They also are, rightfully, taking the lead in educating the public about drinking water safety.

Our local water quality, whether the causative agent or not, was immediately pointed to as the cause of leukemia by the general population, encouraged and perpetuated by the media. The matter has not remained local. We see copies of news articles from across the Nation with headlines proclaiming Fallon and Churchill County to be an unhealthy place to live. This press coverage has resulted in damage to our community. People are turning down jobs, houses go unsold, business has declined, our sales tax revenues are down and we were recently listed as a depressed area by EDA, (Economic Development Administration). (Attachment #8–11).

One of the first questions raised by the general public concerned the use of chemicals and chemical processes in the county, and what regulations were in effect to assure public safety. Churchill County relies on the Nevada Department of Environmental Protection to issue any emissions and/or discharge permits relative to any business or industry that locates in our county. The only county requirement other than proper zoning, until recently, was a business license. Out of concern for the health and well being of our citizens we now require a Special Use Permit. This helps county officials and haz-mat experts know what chemicals are being used in the community. The information required for a Special Use Permit is also intended to assist emergency responders, if the need should arise.

We asked ourselves, what has changed in the community since the early 1990's? Several things emerged. We have no way of knowing which, if any, of them singly or in combination are to blame until more research is done. *Less irrigation water* in the valley to recharge our shallow aquifers: Are toxins building up in the shallow aquifer? *More people on one-acre lots*: Are deep soil disturbances related to building, more fertilizers and pesticides used for landscaping and lawns, or nitrates from septic leach lines to blame? *The 1997 flood*: Was more Mercury or some other toxin that had previously been undisturbed released into the Carson River to end up in Lahontan Valley? *The Gulf War*: Was some toxic or carcinogenic substance introduced to the community when personnel and/or equipment returning from the war came to NAS Fallon? *Transportation of hazardous material*: How much hazardous material is being transported through the city of Fallon in trucks traveling the Highway 95 North/South route, and is it properly contained? *Petroleum based products*: Were there changes made to the chemical formulations of fuels, paints, tars, asphalt, fertilizers, lubricants, etc?

We are anxious to locate and take reasonable corrective action for any environmental cause that may be found to contribute to the incidence of leukemia or like diseases in our community. A thorough and accurate scientific study of all possibilities will take many years and millions of dollars. The medical experts have already expended many resources examining the patients and their families. The community, and individuals have lent their support. The State of Nevada is considering committing money. Now I will ask you to do the same.

• First and foremost is the proper health care for victims of leukemia and related illnesses. Provide special assistance funds to be administered through Social Service programs or special insurance underwriting.

• We need to have thorough scientific research underwritten by Federal Grants. The studies should seek out information on leukemia trends before the cluster appeared for the sake of comparison. There is no doubt that information gathered and analyzed in this area will provide benefit for other areas also.

• Grants to the University of Nevada and Churchill Community Hospital that will enable them to continue public education programs in drinking water safety and nutrition and disease prevention is essential.

• Provide low interest, long-term loans to small business affected by loss of sales through the leukemia scare.

If water is identified as the cause of *ANY* health risk to our citizens we need Federal help to build a system to bring safe water to those who live outside the city limits of Fallon. County Commissioners have been considering this for a long time and have developed a plan for the system including a source of supply. (A Draft Copy of the plan was delivered to Senator Reid in the fall of 2000). The estimated total cost is in the $200,000,000–$250,000,000 range, obviously far beyond the means of a small community, even if our population doubles as predicted. We know the government is developing a plan to assist small community water systems for towns under 10,000 population. Our population outside the city of Fallon is about 16,000, too large to qualify for that assistance, leaving the people who reside in rural Churchill County in a "no win" situation at this time. As a side note, for many years qualified Veterans have not been able to exercise their right to guaranteed home loans in this area because of the water quality. We urge the Federal Government to look at ways to assist areas such as ours to develop safe water supplies.

• In the short term, Federal assistance to help residents with the cost of testing all existing domestic wells and installing treatment systems if the water test results deem a system necessary, would be a blessing to this community. It is estimated that there are about 4500 domestic wells in use at this time, and complete water analysis costs about $120 or more per sample. Cost of various in-home treatment systems range from several hundred to several thousand dollars, amounts beyond the means of many homeowners.

Churchill County Commissioners have approved a proposed hazardous materials by-pass route for this community, with the idea of beginning to acquire rights-of-way for future construction. (Attachment #12) At this time all trucks that travel north/south on US 95 must travel about a mile through the city, turn 90 degrees, travel three blocks and turn 90 degrees again on the three busiest streets in town. There are no truck stops on this stretch of highway for several hundred miles, so hungry, tired truckers must stop beside the street in town where thousands of people pass by. This route is very near four schools. The east/west route is US 50, straight through the heart of town, and passes near two schools and the hospital. If hazardous waste transportation should prove to cause ANY health hazard to our community the Federal Government would be obligated to provide assistance to build a route that keeps the threat of exposure to a minimum.

On behalf of the Churchill County Commissioners, I thank you for taking time to listen to our concerns and ideas. We sincerely hope that you will be able to assist our community in some way to ease the suffering of the leukemia victims and their families and to help us find the ways and means to lessen or better yet, prevent more occurrences of this and other cancers.

RESPONSES BY KEN TEDFORD, JR., MAYOR, FALLON, NV TO FREQUENTLY ASKED QUESTIONS ABOUT CHURCHILL COUNTY LEUKEMIA CASES

Question 1. The city of Fallon prepared this document as a public service. The City is not considered an expert on the subject of leukemia. Sources of information include the State Health Division, National Cancer Institute, Leukemia & Lymphoma Society and American Cancel Society. In addition, information was taken from newspaper articles, Web sites and reports prepared by the City's own environmental consultants. This information is not provided as medical advice or as an official report of scientific research, but as public information.

What are the current findings about the leukemia cases in Churchill County?

Response. A preliminary investigation was conducted by the Nevada State Health Division to ensure that public health officials were aware of all cases of childhood leukemia in the area and to identify any common characteristics among the case families. Case families were asked about their residential history, sources of water

for drinking and cooking, medical history, family history, and potential sources of chemical and radiation exposure.

Eight of the eleven cases have been diagnosed in the last 10 months. Patients' ages at time of diagnosis range from 0 to 19 years old. The cases are scattered throughout Churchill County. All the patients have acute lymphocytic leukemia (ALL). Nationally, 2,000 new cases of ALL are diagnosed each year. None of the children from Churchill County has died from the disease.

State Health officials have completed interviews with 10 case families and data has been examined for eight of the families. Based on an initial analysis, there does not appear to be a common characteristic among the case families. All of them lived in Fallon for varying lengths of time between 1996 and 1999. The families had various sources of drinking water (some drank tap water from the municipal system, some drank tap water from domestic wells, and some drank bottled water) and reported no consistent exposures to any particular environmental hazard. It is however, important to note that people may not always be aware of their exposure to an environmental hazard.

Question 2. What is leukemia?

Response. Leukemia is a form of cancer. Childhood acute lymphocytic leukemia (ALL) is a disease in which too many underdeveloped infection-fighting white blood cells, called lymphocytes, are found in a child's blood and bone marrow. ALL is the most common form of leukemia in children, and the most common kind of childhood cancer. It is also referred to as acute lymphobastic leukemia.

Question 3. What is a cancer cluster?

Response. A disease cluster of any kind is the occurrence of a greater than expected number of cases of a particular disease within a group of people, geographic area, or a period of time. Cancer clusters may be suspected when people report that several family members, friends, neighbors or coworkers have been diagnosed with cancer.

Various statistical methods are used to determine whether the reported number of cancer cases is really a larger number than would normally be expected to occur. True clusters are difficult to define and, if they turn out to be real, the causes are often obscure. Most non-occupational cancer clusters turn out to be the result of the random nature of the disease.

Clusters have been identified throughout the world but only one case can positively be linked with a contaminant. Some high-profile cancer/leukemia cluster cases include: Tom's River, NJ; Hinkley, CA; Woburn, MA; La Hague, France; and Seascale, Britain.

Question 4. How are cancer clusters investigated?

Response. Epidemiologists, scientists who study the frequency and distribution of diseases in populations, may investigate reported disease clusters, including suspected cancer clusters. Investigations of suspected cancer clusters can be limited by the current status of scientific knowledge and tools related to genetics; effects of environmental factors on humans; the availability of statistics on cancer and other diseases by local area; and resources.

Question 5. What causes leukemia?

Response. The cause is unknown.

Question 6. What are the risk factors for childhood leukemia?

Response. For the most part, lifestyle risk factors such as diet and exercise, while important in adult cancers, are not linked to childhood cancers.

Question 7. What are the symptoms of leukemia?

Response. Early signs of ALL may be similar to those of the flu or other common diseases. General symptoms can include feeling tired or weak all the time, weight loss, fever and loss of appetite. Most symptoms of acute leukemia are caused by a shortage of normal blood cells. Anemia is a result of a shortage of red blood cells. Anemia causes shortness of breath, fatigue and a pale skin color. Not having enough white blood cells can increase the risk of infection. Not having enough platelets can lead to bruising, bleeding, frequent or severe nosebleeds and bleeding from the gums.

Question 8. What should I do if I think my child may have leukemia?

Response. Immediately consult your physician or healthcare provider for assistance, evaluation, and early intervention. Your physician will complete tests he or she determines to be needed to make an accurate diagnosis and begin treatment, if necessary. A blood test is required to diagnose leukemia.

Question 9. How is leukemia treated?

Response. Treatment decisions for each child are based on a number of individual factors. It is generally treated with chemotherapy. Chemotherapy refers to the use of anticancer drugs that enter the bloodstream and spread throughout the body to kill cancer cells.

More than 95 percent of children with ALL enter remission after 1 month of treatment. Remission means that about 99 percent of the cancer cells have been killed; but there are still some leukemia cells in the body. That's why further phases of treatment are needed.

Bone marrow transplants are also used in the early stages of some types of leukemia.

Question 10. Can children who have leukemia be cured?

Response. The overall 5-year survival rate for children with ALL is 80 percent. The aim of treatment is to bring about a complete remission. Complete remission means that there is no evidence of the disease and the patient returns to good health with normal blood and marrow cells. Relapse indicates a return of the cancer cells and return of other signs and symptoms of the disease. For leukemia, a complete remission that lasts 5 years after treatment often indicates cure. Treatment centers are reporting increasing numbers of patients with leukemia in complete remission at least 5 years after diagnosis of their disease.

Question 11. Where can I get more information about leukemia?

Response. State Health Division officials have set up a Community hotline, open weekdays between 8am and 6pm for inquiries: 1–888–608–4623.

State Health Division Web site, *Health2k.state.nv.us*

- Leukemia and Lymphoma Society of America, *www.leukemia.org* or 1–800–955–4572
- Childhood Leukemia Center, *ww.patientcenters.com*
- National Cancer Institute, *www.nci.nih.gov* or 1–800–4–CANCER
- American Cancer Society, *www.cancer.org* or 1–800–ACS–2345
- Department of Health and Human Services, *www.os.dhhs.gov/*
- Centers for Disease Control, *www.atsdr.cdc.gov/*

Question 12. What caused these cases of leukemia in the Fallon area?

Response. The Fallon leukemia cases are the State Health Division's top priority and investigators are looking into many theories for the unexpected concentration of cases. During a public meeting on February 5, officials from the Health Division stated that they are not ruling out the possibility of a cause, but acknowledged that this occurrence could be happenstance, a statistical anomaly.

Question 13. Is there an elevated rate of other types of cancer in Fallon?

Response. The State's Cancer Registry has been analyzed and Churchill County does not have an increased rate of any other types of cancer.

Question 14. What is being done to investigate these cases?

Response. The State Health Division is conducting an extensive epidemiological investigation. The investigation, which began 6 months ago, centers on collecting and analyzing data. Much of the data consists of statewide statistics and information from the 11 children and teens with leukemia as well as their families. The Health Division is including experts from the Centers for Disease Control and Prevention (CDC) and other States to assist with this investigation. Environmental sampling and other testing may follow.

The city of Fallon has retained a nationally recognized environmental and engineering consulting firm, Shepherd Miller, to conduct chemistry testing of the city's water.

Question 15. Are other government officials getting involved?

Response. The Nevada Legislature is holding hearings in Carson City. The goal of these hearings will be to unite data, resources and information in an effort to share information and address concerns. Participating in the effort is the city of Fallon, the Environmental Protection Agency (EPA), Nevada State Health Division, Nevada Division of Environmental Protection and the Nevada Department of Agriculture. Also testifying will be experts on arsenic, leukemia, drinking water and pesticides.

U.S. Senator Harry Reid has said that Federal officials, including representatives of the Centers for Disease Control in Atlanta and a congressional health committee are expected to get involved in the investigation. Reid said he would send environment committee staff members and an eco-toxicologist to Fallon to conduct preliminary interviews and gather information. An initial investigation is scheduled for mid-February with a field hearing to be held in the spring.

Question 16. How long will it take to determine the cause?

Response. Hundreds of cancer clusters have been investigated, some for many years, and only one clearly identified a cause. Although this is discouraging, the Health Division believes it is important to properly investigate these cases.

Question 17. Could Navy jet fuel be the cause?

Response. According to the commander of the Fallon Naval Air Station jet fuel spills and fuel dumping by planes are so rare and well documented that the fuel cannot be a contribution factor in the childhood leukemia cases. The base has 100 monitoring wells and no fuel contamination has been recorded off Navy property. No jet fuel has contaminated the municipal water supply.

Question 18. Is there a link between atomic tests and leukemia?

Response. Department of Energy officials say that radiation from the test has not migrated from the site to Fallon. The test wells have been monitored since 1963 and the EPA checks the wells annually. Scientists from the energy department, EPA and Desert Research Institute use eight onsite wells and a dozen offsite wells to search for radioneuclides like tritium. The ground water below the test site does not connect with the basalt aquifer, Fallon's source of drinking water. Fallon is 28 miles from the site of a 1963 nuclear bomb test.

Question 19. Where does the City of Fallon's water come from and why is arsenic in the water?

Response. The city's water source has been an underground basalt aquifer for the past 58 years. Water is withdrawn from the aquifer through four deep wells. Arsenic is a naturally occurring mineral. The amount of arsenic in Fallon's drinking water is 100 parts per billion.

The city of Fallon Municipal Water System routinely monitors for constituents according to Federal and State laws. The City monitored for 49 synthetic organic compounds and 56 volatile organic compounds and there were no detected quantities of any of these contaminants.

Question 20. Is there a link between the arsenic and leukemia?

Response. There is currently no evidence that arsenic causes childhood leukemia. Dr. Randall Todd, the State epidemiologist, says it's unlikely the longstanding occurrence of arsenic caused a sudden spike in the area's leukemia rate. The water has been tapped from the same source for 58 years with no reported clusters of any type in the past.

Question 21. What is the City doing to take the arsenic out of the water?

Response. In 1990, The city of Fallon entered into a Compliance Schedule Agreement to remove arsenic from its public water supply once a standard was set. The City has been waiting for a permanent Federal standard on acceptable levels; that standard appears to have been set by the outgoing Clinton administration.

The City has been distributing quarterly notices to customers that advise using alternative sources for drinking water, including bottled water, filtered water available for purchase at grocery stores or water filtered at home through a reverse osmosis system.

In April 2000, the City retained a nationally recognized environmental and engineering consulting firm, Shepherd Miller, to conduct chemistry testing of the city's water. These tests are ongoing in order to rule out suspected leukemia causing agents. The next phase includes testing for three other substances in order to exhaust all possibilities.

The City has exceeded required testing requirements, in both the frequency of testing and the types of contaminants. Additional tests have been completed on contaminants, that are linked, or suspected to be linked, to leukemia. Water tests show no contamination from fuel, radiation, pesticides, or herbicides.

The City is working with Shepherd Miller to determine which arsenic treatment technologies are best suited to Fallon's water chemistry and will be installing a treatment system to meet all Federal requirements.

The design of a treatment facility is scheduled for completion by June 30, 2002 and startup testing will begin June 15, 2003. Initial compliance for arsenic removal should commence September 15, 2003. The City is on target to make these EPA deadlines.

Question 22. Should I have my private well for drinking water tested?

Response. If you don't know what's in your well, you should have it tested. You should know the arsenic levels, bacteria levels, and other contaminants present. You should contact the Health Division hotline at 1–888–608–4623 or Bureau of Health Protection Services in the Nevada State Health Division, 775–687–4750 extension 237.

Question 23. What can I do to help the families?

Response. West End Elementary School is participating in the Pennies for Patients campaign to raise funds for the Leukemia and Lymphoma Society. Additional information on fundraisers and community support activities will be provided as it becomes available.

Table 5.2.—Historical Lahontan Valley Underground Water Quality & MCL Exceedence[1]

Constituent	MCL (ppm)	No. of Records Which Exceed MCL's[2]	Percent of Records Which Exceed MCL's
TDS	500	1103	40
Magnesium	150	30	1
Sulfate	250	368	13
Chloride	400	117	4
Nitrate	10	590	21
Flouride	2	203	7
Arsenic:			
Current Standard	0.05	955	34
Anticipated EPA Standard	0.01	1898	68
Detection Level	0.002	2656	95
Iron	0.6	188	7
Manganese	0.1	810	29
Copper	1	2	0
Zinc	5	1	0
Barium	2	0	0
Color	15	342	12
pH	6.5–8.5	506	18

[1] See Appendix 5.2 which is a tabulation of the water quality records sorted by Township, Range & Section

[2] There are a total of 2,792 records in the data base, however some of them are duplicate wells sampled at different dates.

Dixie Valley Ground Water.—Based upon current MCLs, the water quality of the ground water in the Settlement area within Dixie Valley is good. Based upon 13 well analyses, the average TDS is 264 ppm and individual wells vary from 152 ppm to 355 ppm. Higher TDS (in the order of 800 ppm to 1000 ppm) is reported in 2 wells located 17 to 20 miles north of the settlement area. (These areas to the north near the playa are not included in the proposed well field for the Dixie Valley Ground Water Development Project.).

HOW TO TEST YOUR DRINKING WATER

The Nevada State Health Division recommends that individuals with private wells do a bacterial analysis every 6 months and a chemical analysis once a year. When testing for personal reasons, a chemical test costs $100 and a bacterial test costs $12.

To Prepare Water for Bacterial Testing: 423–2281.—You can get sterile bottles from the Churchill Community Hospital (Business Office) located at 801 E. Williams in Fallon or the Nevada State Health Laboratory (address on attached forms). *Carefully follow the directions* on the form for taking samples. These can be mailed in a mailer provided with the bottle.

To Prepare Water for Chemical Test.—Use a clean 1-gallon plastic container. You can purchase a bottle of distilled water in your grocery store, empty it and refill with your water as outlined in the attached directions.

Where to take Samples: (775) 688–1335.—Take your sample to the State Lab on the University of Nevada, Reno, campus. The lab is located just west of the Medical school and north of Lawlor Events Center. The address is 1660 N. Virginia. Take Virginia Street north to Seventeenth Street, turn right, go 0.1 mile to the second stop sign, turn left, and the lab is immediately on the left after the left turn.

Reading Your Test.—Enclosed are samples of the report sheets that will have the results from your test. If you need help understanding the results or have questions, contact the local health department (423–2281) or your County Extension Office (423–5121).

When you receive test results compare them with the Federal drinking water standards found below.

Federal Drinking Water Standards

[Primary and Secondary Contaminate Levels]

Contaminant	Max Level
Primary Regulations:	
Inorganic Chemicals	
Arsenic	0.05 mg/L
Barium	1 mg/L
Cadmium	0.010 mg/L
Chromium	0.05 mg/L
Lead	0.05 mg/L
Mercury	0.002 mg/L
Nitrate (as N)	10 mg/L
Selenium	0.01 mg/L
Silver	0.05 mg/L
Flouride (depending on temperature)	1.4–2.4 mg/L
Organic Chemicals:	
Endrin	0.0002 mg/L
Lindane	0.004 mg/L
Methoxychlor	0.1 mg/L
Toxaphene	0.005 mg/L
2,4–D	0.1 mg/L
2,4,5–TP Silvex	0.001 mg/L
TTHM	0.10 mg/L
Turbidity	1 TU–5 TU
Coliform Bacteria	1/100 ml (mean)
Radiological:	
Radium 226 and 228	5 pCi/L
Gross Beta	4 mrem/year (50 p Ci/L)
Gross Alpha	15 pCi/L
Sodium & Corrosivity	Monitoring only
Secondary Regulations:	
Chloride	250 mg/L
Color	15 color units
Copper	1 mg/L
Foaming Agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor	3 threshold odor number
PH	6.5–8.5
Sulfate	250 mg/L
TDS	500 mg/L
Zinc	5 mg/L

Bacteriological Test, Nevada State Health Laboratory, Reno, NV

DIRECTIONS FOR TAKING WATER SAMPLES

Caution.—Bottle is sterile and contains a bit of necessary powder. Do not open bottle until Step 5 below and *Do not wash out bottle.*

Procedure

1. Select sampling outlet closest to the water source (pipe, kitchen faucet, etc.)
2. Remove aerators, hoses, sprinklers, etc., from the fixture.
3. Turn on valve and let water run for 2 to 3 minutes.
4. While water is still running, unscrew the bottle cap carefully. Do not touch mouth of bottle.
5. *Do not rinse bottle, but fill to the shoulders; replace the cap and tighten firmly. 100 mls of water are required for testing.*
6. For samples from an open reservoir, make a quick pass with mouth of bottle forward at a depth of one foot. Tighten cap firmly.
7. Complete information slip with your name, location, county, date, time of sampling, and return mailing address.

8. Submit sample(s) to laboratory within 30 hours of collection and maintain temperature below 20° C (68° F) during shipment or sample is unsatisfactory. (Do not allow to freeze.

9. Do not mail sample(s) on Friday, because our laboratory is closed on the weekend. Samples mailed on Friday and received on Monday cannot be tested because the 30-hour time limit will be exceeded.

10. Please do not bring Fecal Streptococci water samples on Friday.

NOTE: This test indicates only if coliforms are present or not present. Drinking water should have no coliforms present.

A 09386

NEVADA STATE HEALTH LABORATORY
NEVADA DIVISION OF HEALTH
1660 N. Virginia Street
Reno, Nevada 89503

Sampler..... Date..... Hour.....

Location..... County.....

Public Water System Name.....

ID No.....

Chlorine Residual.....

THIS SPACE FOR LAB USE ONLY

YOUR RETURN ADDRESS

Name.....

Address.....

.....

☐ Drinking Water Analysis

Methods:

☐ Membrane Filter ☐ MPN

☐ Presence/Absence ☐ Other.....

Results:	PRESENT	ABSENT
Total Coliform.....	☐	☐
Fecal Coliform.....	☐	☐
E. Coli.....	☐	☐

Date..... Tech.....

The absence of coliforms meets Nevada State Health Division bacteriological standards for safe drinking water.

Invalid Sample Please Repeat ☐

Received > 30 Hrs..... ☐ Confluent Growth..... ☐

Received > 20°C..... ☐ Other..... ☐

> 200 Other Bacteria... ☐ .....

Sediment..... ☐

☐ Raw or Wastewater Analysis

Methods:

☐ Membrane Filter ☐ MPN

☐ Other.....

PAID NSHL

Test Required: (Dilutions if Needed)	RESULTS
Total Coliform 1:.....	...../100ml.
Fecal Coliform 1:.....	...../100ml.
Fecal Streptococcus 1:.....	...../100ml.

Date..... Tech.....

(O)-3319 (Rev. 8-90)

WATER BACTERIOLOGY

SAMPLE

NEVADA STATE HEALTH LABORATORY
1660 NORTH VIRGINIA STREET
RENO, NEVADA 89503
(775) 688-1335

SAMPLING INSTRUCTIONS FOR CHEMICAL/MINERAL ANALYSIS: All samples are subject to fees!!

EACH SAMPLE MUST BE COLLECTED IN A 1/2 GALLON OR ONE GALLON PLASTIC DISTILLED WATER BOT PROVIDED BY THE SAMPLER. PLEASE WRITE THE SOURCE ADDRESS ON EACH BOTTLE IN PERMANENT I

Please fill out the information below as completely as possible and return this form wi the sample. TOWNSHIP, RANGE AND SECTION ARE REQUIRED; THIS INFORMATION IS COMMONLY ON DEED TO THE PROPERTY. WELL DRILLER'S REPORT OR MAY BE OBTAINED FROM THE COUNTY RECORDER OFFICE. Please indicate any special requests on the back.

Elementary sampling instructions are printed on our Water Chemistry Analysis form. The sampling method should result in a sample that is representative of the problem or sour being sampled. Thus we routinely make the following recommendations:

1) For a new well or one that has not been in use recently, the well should be pum long enough to clean out the casing and develop the aquifer that will serve the wel A 24 hour pump should accomplish this, but care should be taken not to pump the wel dry.
2) Wells currently in use need less pumping and we recommend a four (4) hour pump.
3) For wells with a sanding problem, reducing the flow to one or two gallons per minute for 30 minutes after an initial pump as outlined above has helped eliminate problem.
4) Samples from filters and distribution systems should be collected after the wat has run long enough to clear the lines between the sampling point and the source. minutes should be adequate for this.

NOTE: An outside faucet should be used when pumping a well; THE SAMPLE SHOULD BE TAKEN FROM THIS FAUCET. It may be possible to flood a septic system if an inside faucet is used.

WATER CHEMISTRY ANALYSIS:

Attn: Fees may apply to some types of samples.

All of the information below must be filled in or the analysis will not be performed.

State.....County.....
Township.....Range.....Section.....
General Location.....
Source Address.....

TYPE OF ANALYSIS:

☐ Check here for ROUTINE DOMESTIC ANALYSIS.
Circle the constituents needed for PARTIAL ANALYSIS.

SAMPLING INSTRUCTIONS:

The sample submitted must be representative of the source. Spring and surface water samples should be as free of dirt and debris as possible. Wells should be pumped thoroughly before sampling, changing the water in the casing at least three times. Product water from filters should be sampled after running for about ten (10) minutes.

Sampled by.....Date.....
Owner.....Phone.....
Address.....
City.....State.....

REPORT TO:

Name.....
Address.....
City.....
State.....Zip.....

REASON FOR ANALYSIS:

☐ Loan
☐ Personal health reasons
☐ Purchase of the property
☐ Rental or sale of property
☐ Subdivision approval
☐ Other.....

USE OF WATER:

☐ Domestic drinking wa
☐ Geothermal
☐ Industrial or mining
☐ Irrigation
☐ Other.....
Initials.....

SOURCE OF WATER:

Filter ☐ Yes ☐ No
Public ☐ Yes ☐ No
Spring.....
Well.....Depth.....ft.
Hot.....Cold.....
IN USE ☐ Yes ☐ No

Type.....
Name.....
Surface.....
Casing diameter.....in.
Casing depth.....ft.

**********LABORATORY USE ONLY**********

FEE_____ By_____ METHOD_____ RECPT DATE

IN TRIPLICATE
(PLEASE PRINT OR TYPE)

NEVADA STATE HEALTH LABORATORY
NEVADA DIVISION OF HEALTH
1660 N. Virginia Street
Reno, Nevada 89503
(775) 789-0335

SAMPLE

WATER CHEMISTRY ANALYSIS:

Attn: Fees may apply to some types of samples.

All of the information below must be filled in or the analysis will not be performed.

State ..... County .....
Township ..... Range ..... Section .....
General Location .....
Source Address .....

TYPE OF ANALYSIS:

☐ Check here for ROUTINE DOMESTIC ANALYSIS.
Circle the constituents needed for PARTIAL ANALYSIS.

SAMPLING INSTRUCTIONS:

The sample submitted must be representative of the source. Spring and surface water samples should be as free of dirt and debris as possible. Wells should be pumped thoroughly before sampling, changing the water in the casing at least three times. Product water from filters should be sampled after running for about ten (10) minutes.

Sampled by ..... Date .....
Owner ..... Phone .....
Address .....
City ..... State .....

REASON FOR ANALYSIS:

☐ Loan
☐ Personal health reasons
☐ Purchase of the property
☐ Rental or sale of property
☐ Subdivision approval
☐ Other .....

USE OF WATER:

☐ Domestic drinking water
☐ Geothermal
☐ Industrial or mining
☐ Irrigation
☐ Other .....
Initials .....

REPORT TO:

Name .....
Address .....
City .....
State ..... Zip .....

SOURCE OF WATER:

Filter ☐ Yes ☐ No
Public ☐ Yes ☐ No
Spring .....
Well ..... Depth ..... ft.
Hot ..... Cold .....
IN USE ☐ Yes ☐ No

Type .....
Name .....
Surface .....
Casing diameter ..... in.
Casing depth ..... ft.

The results below are representative only of the sample submitted to this laboratory.

FOR LABORATORY USE ONLY

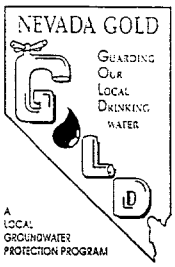
Constituent	ppm	Constituent	ppm	Constituent	ppm	Constituent	S.U.	PRINT OTHER DESIRE CONSTITUENTS BELO Constituent	
T.D.S. @ 103° C.		Chloride		Iron		Color			
Hardness		Nitrate		Manganese		Turbidity			
Calcium		Alkalinity		Copper		pH			
Magnesium		Bicarbonate		Zinc					
Sodium		Carbonate		Barium					
Potassium		Fluoride							
Sulfate		Arsenic							

Fee .....
Collected by .....
PWS I.D. .....
SDWA—Pri ..... Sec .....
1st ..... 2nd ..... 3rd .....
Date Rec'd ..... Init .....
ppm = parts per million, milligrams per liter
S.U. = Standard Units

Remarks .....

APPROVED

#4



Nevada GOLD and Churchill Community Hospital

Free Courier Service

We have teamed up to make water testing more convenient. You can now purchase bacteriological test kits from the hospital. When you collect your sample bring it back to the hospital, where our courier service will transport it to the State Laboratory for you.

For information call:
Nevada GOLD Coordinator at 423-5121

Don't Delay Have Your Water Tested Today !

(FORM: GOLD11)

#5

ATTENTION

NEVADA GOLD
GUARDING OUR LOCAL DRINKING WATER
A LOCAL GROUNDWATER PROTECTION PROGRAM

If you have a domestic well.

TEST YOUR WATER

AT LEAST ONCE A YEAR FOR

pH, NITRATE, TDS & BACTERIA.

Nevada State Lab Fees

CHEMICAL ANAYSIS		BACTERIA TEST	
PH	$ 2.00		
Nitrate	$ 12.00	Bacteria	$12.00
TDS	$ 11.00		
Administrative	$ 6.00		
Total:	$ 31.00	Total:	$12.00

(GOLD 10)

Fact Sheet 92-4 #6

Nevada Cooperative Extension • University of Nevada, Reno

DRINKING WATER IN CHURCHILL COUNTY

Mary E. Reid
Central Area Specialist
Water Resources

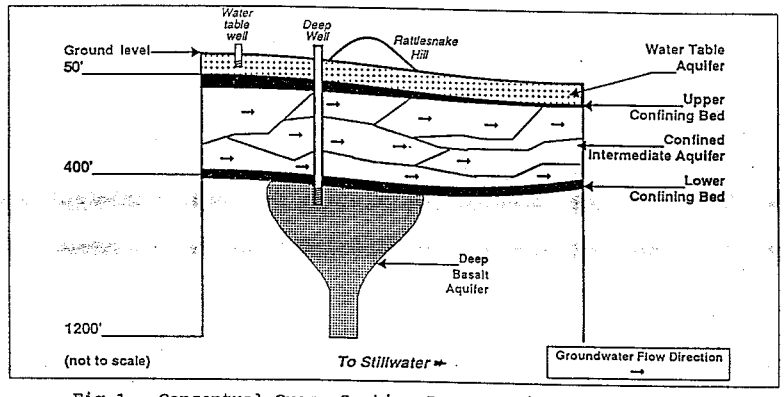


Fig.1. Conceptual Cross Section Representing Churchill County's Aquifers

For residents of Churchill County, drinking water is supplied by underground aquifers from which groundwater is pumped. Drinking water may come from City of Fallon deep, municipal wells, from a community well which serves a number of households, or from an individual well on private property. Wells for the city of Fallon pump water from a deep basalt aquifer located beneath the city. Most private wells pump water from the shallow water table aquifer located between the ground surface and roughly fifty feet below the surface. (See Fig. 1) There is uncertainty about exactly how local drinking water aquifers are recharged, but water delivered to Newlands Irrigation Project water users undoubtedly influences recharge to the

drinking water aquifers as irrigation water seeps into the ground from canals, drainage ditches and agricultural fields in the area.

Water in Churchill County tends to have a pH higher than 7. In many places in the county, naturally occurring arsenic is found in drinking water at levels that exceed the maximum level recommended by the U.S. Environmental Protection Agency. The water tends to be high in salts. There are problems with manganese and hydrogen sulfide gas in some parts of the county. Manganese does not generally pose a health risk but it does discolor bathroom fixtures, buildings, and clothing washed in the water. Hydrogen sulfide gas, likewise, is not a health problem but it has a characteristic rotten egg odor many find unpleasant.

*Water Quality Variability

Underground deposits in Lahontan Valley are layered and variable. Because soil constituents in Lahontan Valley are highly variable, the constituents found in well water vary. As it passes through soil, water dissolves constituents contained in the soil. Two neighbors with wells drilled within ten feet of each other can have water of different quality in Churchill County.

*Geographic Variability

Within the Newlands Irrigation Project boundaries in Churchill County, both surface water for irrigation and underground water that supplies wells, move in a general direction from west to east (See Figure 1). As irrigation water moves across the Newlands Project from west to east and is used for irrigation of farmland, the tendency is for the water to contain an increasing amount of salts.

In addition to receiving drainwater from the Newlands Irrigation Project, property located at the eastern edge of the Newlands Project contains soil and water with naturally occurring concentrations of salts. The area known as Stillwater, and the Carson Lake Pasture, are sinks which are low areas where water has naturally drained for many years. These low areas tend to have soils with higher clay content than soils in areas of higher elevation. As water drains to these sink areas and evaporates, the salts become concentrated.

WELL DESCRIPTION

Simply described, a well is a pipe (casing) placed in a hole in the ground. The pipe has perforations (a screen)at specified depths to allow water to enter it. (See Figure 2) A water-table well should be located on high ground with the water level in the well higher than any nearby source of contamination. If the well must be located on low ground, it should be located at a safe distance from any source of contamination. The well should be located so that

surface water cannot enter. The well casing should extend 8 inches above the surface of the ground, and the casing should be sealed with an approved well cap to prevent contamination.

To prevent contamination below ground, the casing should be protected by grout for a specified distance, usually at least 20 feet. (See Figure 2) A poorly designed or poorly maintained well built without grout or with an improperly designed gravel pack will allow sand and sediment to enter the well. A well without grout, or an abandoned well, provides a direct pathway for contaminants to enter groundwater.

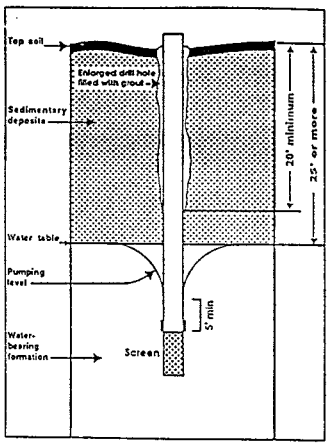


Fig.2. Example of a properly constructed well.

PRIVATE WELLS

Individual property owners with private wells must take personal responsibility for the quality of their drinking water. No routine state testing is done on private wells.

Most of the private wells in Churchill County are less than thirty feet deep. Very few have much protection such as clay layers above the casing perforations to protect them from surface contaminants. Annual testing of the water should be routinely done. Individual, privately owned "public" wells, such as those at restaurants in the county, are monitored by the State of Nevada.

The closer a well's perforations are to the surface, the more easily the water can be contaminated by substances at the surface which move through the soil into groundwater.

*Water Test Records

The State of Nevada's Division of Consumer Health of the Department of Human Services has results on file for any prior water testing done at a given address.

The State of Nevada's Division of Water Resources of the Department of Conservation and Natural Resources has copies of well drillers' logs. This information can be obtained by providing the parcel number (APN number) of the property. Also needed are the section, township and range where the well is located.

COMMUNITY WATER SYSTEMS

Private community water systems that serve fifteen or more households,

like public water systems, must meet state standards for water quality and must be tested regularly. These include many mobile home parks and small subdivisions. In Churchill County, the wells for these systems are usually shallower than the four public wells used by the city of Fallon. The depth of comunity wells is usually between 25 and 100 feet.

CITY OF FALLON

In the City of Fallon there are four wells in a deep basalt aquifer from which water is pumped, treated and supplied to residents by the City of Fallon Water Company. The city wells go to an average depth of 400 feet.

Drinking water quality for Fallon is tested regularly and monitored by the Health Division of the Nevada State Department of Human Resources.

*Arsenic

Fallon's water does not currently meet the minimum U.S. Environmental Protection Agency maximum contaminant level of 0.05 milligrams of arsenic per liter of water. The city is under a compliance schedule that is being monitored by the State of Nevada's Division of Consumer Health of the Department of Human Services.

There have been no statistically validated scientific studies done in the United States to date to show a conclusive relationship between health problems and the arsenic levels present in Fallon's water. Many longterm residents and local officials believe that the levels of arsenic present in the city water do not pose a sufficient health risk to warrant the expense that treatment requires. Other residents choose to buy bottled water or to treat their drinking water at home.

For further information:
Nevada Department of Human Resources: Division of Consumer Health Protection
423-5136 (Local Contact)
687-4750 (State Office)

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STATEMENT OF MARY E. REID, AREA SPECIALIST, WATER RESOURCES, UNIVERSITY OF NEVADA, COOPERATIVE EXTENSION

INTRODUCTION

• Common Problems with presence of arsenic in drinking water See Health effects below.

• Drinking Water Standards: Federal Standard for Maximum Contaminant Level (MCL)

0.05 milligrams per liter (mg/l)

0.05 parts per million (ppm)

• Special characteristics (odors, colors, etc.)

None

• To identify. Actions to take if thought to be present.

No simple home test available. If thought to be present, bottled water is an option.

To ascertain presence and levels in water. Sampling procedure.

If known to occur in the general geographical area, an inorganic chemistry test for presence and level of arsenic present must be done in a laboratory. In Nevada, a standard inorganic water analysis done by the Nevada State Laboratory includes testing for arsenic.

• Areas in Nevada where arsenic is found in drinking water

Carson Valley, Cold Springs, Eagle Valley, eastern sides of the Truckee Meadows, Fallon, Fernley, Hazen, Hidden Valley, Topaz, Verdi, and Virginia Foothills.

SOURCES

Arsenic occurs naturally in rocks, soils and sediments. High levels may occur in some coals. High levels of arsenic have been found in water from areas with geothermal activity. Marine algae and seaweed usually contain considerable amounts of arsenic.

Arsenic is used in the manufacture of pesticides and is also used in making glass and glassware. Other industrial uses for arsenic include copper and lead alloys and pharmaceuticals. Trace amounts of arsenic may be found in some fertilizers.

The burning of coal and smelting of metals are major sources of arsenic in air. Industrial waste from electroplating can be a source of arsenic in water. Water used for geothermal energy production may contain high levels of arsenic.

HEALTH EFFECTS

Arsenic is a poison in humans at 100 milligrams or more and has proved lethal at 130 milligrams. Health effects of long term exposure to elevated arsenic are vague and not clearly defined. Acute and chronic toxic effects may include chronic gastro-intestinal upset and diarrhea, liver damage, nervous system changes, blood imbalance, and skin changes. Exposure to inorganic arsenic can cause skin cancer, mainly tumors of low malignancy.

Arsenic has been associated with pulmonary cancer in the manufacture and use of arsenic-containing pesticides and in the smelting of copper.

REMOVAL FORM DRINKING WATER

Distillation and reverse osmosis are two practical methods of home treatment for drinking water that contains arsenic.

Treatment type	Average Purchase Cost
Distillation	$100–$800
Reverse Osmosis	$90–$800

SUMMARY

Arsenic has been shown to affect health and is an undesirable constituent in drinking water. If drinking water exceeds the Federal standard for arsenic, there are methods for treating the drinking water that will reduce the arsenic level. No home treatment method should be considered without having a laboratory test of the water first.

As with any home treatment method for water, it is not possible to install a reverse osmosis or a distillation unit and forget it. Both require ongoing monitoring

and maintenance. The only way to tell that a unit is functioning properly is to do regular water tests.

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CHURCHILL ECONOMIC DEVELOPMENT AUTHORITY AND SMALL BUSINESS DEVELOPMENT CENTER,
Fallon, NV, April 6, 2001.

Hon. GWEN WASHBURN, *Chairman,*
Churchill County Commissioner,
Fallon, NV.

Ref: Childhood Leukemia Business Impact

DEAR CHAIRMAN WASHBURN: In reply to your questions in regards to impacts to the Fallon, Churchill County business community.

Our office has received calls from several businessman stating that they see a decline in their business, due to the adverse publicity that has proliferated as a result of the leukemia cluster in Fallon, Churchill County. they have concerns for the viability of their business if the publicity is sustained over a long period.

It goes without saying that the most important concern of Churchill Economic Development Authority is the welfare of the leukemia victims, however we also have concerns for our local business community as well. Should the adverse publicity in regard to our arsenic problems, coupled with the acute lymphocytic leukemia cluster continue, there is no doubt that some local business will suffer.

In checking with banks, rental estate and title companies there definitely is a slow down in the sale of homes, and many of the Navy personnel wives do not want to move to Fallon.

I hope this answers your question. If our office can be of further assistance, please feel free to contact us at your convenience.

Sincerely,

SHIRLEY G. WALKER,
Executive Director.

FALLON AUTO MALL,
Fallon, NV, February 8, 2001.

Mayor KEN TEDFORD,
City Hall,
Fallon, NV.

DEAR KEN: I am writing you today purely on an informational basis only.

In regards to the recent publicity Fallon has been receiving over it's water quality, (arsenic content), child leukemia cases, and now our most dangerous Hwy. 50, I feel it is important to rely the impact these pubic images are playing on our local economy.

In our dealership, which commonly does 50 to 60 percent of our business to folks outside our county, we have found this business to be off as much as 40 percent.

In comments we receive regularly we believe much of this loss is directly due to the new image of Fallon by outsiders.

Now, I am sure you are treating these issues with the highest priority possible, but I felt that you should know directly the economic impact this publicity is having on local business.

I trust you will do everything possible in your power to address these issues and promote Fallon as a great place to lie and do business.

Sincerely,

KURT HENNING,
President.

[NAME DELETED]
ATTORNEY & COUNSELOR AT LAW,
January 21, 2001.

ARTHUR MALLORY,
THOM STOCKARD,
365 S. Maine Street,
Fallon, NV.

Re: Current Status

DEAR MR. MALLORY AND MR. STOCKARD: I wanted to write this letter so that I could inform you of my decision as soon as possible. I will be working all day Monday and will not have the chance to speak with you. I am concerned about the water in Fallon. We addressed it briefly when I was out there but since then I have read a few other reports, lastly one in our paper here saying that two more cases of childhood illness could be linked to Fallon.

I am concerned because of the possibilities. My wife and I have two kids, she is pregnant with a third and we anticipate having at least one more. I do not know that the water is a problem, but I could not live with myself if we moved there knowing that there was a possibility for problems and then something were to happen.

The problem is I was looking forward to receiving an offer and working out in Fallon. I wanted to let you know that if something could be worked out I would still like to work there, I know that you are looking for someone who will live in Fallon. I understand the reasons and if I was in your position I would want the same thing. If you cannot find someone that you like, I would propose something else. I could live in Sparks and commute. I could commit to be there for the months that I am on call by either renting a place or making other arrangements. I could also commit to stay for at least 5 years. That would let the water situation sort itself out, and as an incentive it would also be the time period for any retirement to vest.

I know that your first option is someone to live out there, however if you cannot work that out please consider this proposal. I will not be coming out on Thursday, as we have decided that we cannot live in Fallon until we know more about the water situation and that will probably take some time to sort out. If something cannot be worked out it was a pleasure to have met you both and I appreciate your hospitality. If there are any questions please do not hesitate to call or write. I hope to hear from you.

Sincerely,

[NAME DELETED]

STATEMENT OF HENRY FALK, M.D., ASSISTANT ADMINISTRATOR, AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY, PUBLIC HEALTH SERVICE, U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

Good afternoon Mr. Chairman and members of the committee. My name is Dr. Henry Falk, Assistant Administrator of the Agency for Toxic Substances and Disease Registry (ATSDR).

Thank you for inviting ATSDR to speak with you today. We share your concerns about the health and well being of children and families in Fallon and across the country. We also share your desire to adequately address the concerns expressed about illness and disease that might be associated with the environment. In fact, addressing these types of concerns is at the root of ATSDR's creation.

ATSDR is a Federal agency created by Congress in 1980 by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), or what is more commonly known as Superfund legislation. As such, ATSDR is the public health agency charged with determining the nature and extent of health problems at Superfund sites including Federal Superfund sites, and advising the U.S. Environmental Protection Agency (EPA) and State health and environmental agencies on needed clean-up and other actions to protect the public's health.

ATSDR works in close collaboration with the EPA, other Federal, State, local, and tribal governments, health care providers and affected communities. As an agency

of the U.S. Department of Health and Human Services (DHHS), ATSDR has made a difference to all of these partners by providing new information to assist in remedial decisionmaking and evaluation. Our work includes answering the health questions of impacted community members, recommending preventive measures to protect public health, and providing diagnosis and treatment information to local health care providers. ATSDR administers public health activities through: partnerships; public health assessment and consultation activities; exposure investigations; health studies and registry activities; development of toxicological profiles and attendant research; emergency response; health education and health promotion; and community involvement.

ATSDR works in particularly close coordination with our DHHS sister agency, the Centers for Disease Control and Prevention. Jointly we have worked with the Nevada Health Division to investigate the cancer cluster in Fallon. For our part, ATSDR will assist in the investigation by reviewing all relevant environmental data for toxic substances and assessing whether people have been exposed to any of these contaminants at levels of concern.

Unfortunately, the cancer cluster in Fallon is not a unique situation. Increasingly, ATSDR is being asked by State and local health departments to help respond to compelling community concerns about apparent outbreaks of serious, noninfectious disease with unknown cause. As a small agency, responding to these requests would be impossible for ATSDR alone. To supplement our own staff, ATSDR works in close collaboration with State health departments, and has been funding environmental public health activities in States since 1987. ATSDR currently funds public health activities in 28 States through separate cooperative agreements that provide assistance to conduct public health assessments, health education activities, and epidemiologic studies. Because of our Superfund mandates, most of our cancer cluster investigations and assistance are related to concerns about Superfund sites, hazardous waste, and exposure to toxic substances.

The site work we do directly or through our State partners has changed over time. Our original mandate under Superfund called for public health assessments at all National Priorities List (NPL) sites and these originally constituted the great majority of our workload. While we still actively work at NPL sites, it now constitutes a smaller proportion of our site activities. Increasingly, our site work now is at immediate removal sites, active waste sites, occasionally Brownfields sites, and, like Fallon, sites where communities, States or congressional officials have petitioned ATSDR to investigate or assist in evaluating their health concerns related to toxic substances.

Activities related to the vermiculite mine in Libby, Montana, provide a very good example of a current site where ATSDR's work has made a difference, which also began with a reported cluster of disease. The situation in Libby offers a dramatic example of past exposure resulting in serious disease. In 1999, reports from Libby documented cases of non-occupational asbestos-related pulmonary impairment among family members of former mine employees as well as others in the community with no connection to the mining operations. They were suffering (or dying) from asbestosis, mesothelioma, and lung cancers related to their asbestos exposure. Finding non-occupational asbestos-related pulmonary disease is extremely unusual and suggests that dangerous levels of asbestos exposure have occurred within the Libby community. The latency period for mesothelioma, for example, is 40 years. This means that the health care community could be seeing the effects of exposure to asbestos-contaminated vermiculite from Libby for an entire generation.

In 2000, ATSDR conducted a medical testing program to assess the public health implications of past human exposure to tremolite asbestos in Libby. More than 6,100 Libby-area residents and former mine workers were screened. This number included 70 from Elko, Nevada, who met the screening criteria for Libby. They all answered an extensive questionnaire about their possible exposures and received both chest x-rays and pulmonary function tests.

ATSDR recently reported a preliminary analysis of the medical testing results from the first 1,078 participants, or 18 percent of the total number of participants in the medical testing program. These results showed a very high percentage of individuals reporting contact with the vermiculite, and evidence of health impacts, particularly in the form of thickening and scarring of the outer pleural lining of the lung.

ATSDR will soon complete the evaluation of the Libby medical screening program and is working with local, State, and Federal health care providers to address health issues that are identified. Specifically, to help local residents obtain medical care, ATSDR has worked closely with the DHHS Regional Health Administrator and other DHHS agencies, such as the Health Resources and Services Administration (HRSA), and the State of Montana to ensure appropriate treatment is available.

Such partnerships are critical to providing needed health services at Libby, Elko, and now Fallon. Such partnerships are also critical to fully assessing the true existence and potential cause of disease clusters. As a part of the latter, ATSDR and CDC are reviewing and responding to the Pew Environmental Health Commission Report. The report recommends strengthening Federal, State and local public health capacity to tackle environmental health problems and establish a nationwide Health Tracking Network on chronic diseases and related environmental hazards. ATSDR has made significant progress in developing registries of individuals exposed to specific substances and tracking them over time to assess health status and provide updated information over time to exposed individuals. At the request of Sen. Baucus (D-MT) and others, we plan to establish a registry of vermiculite exposed individuals from the Libby area. The agency also has considerable experience working with State health departments and communities to conduct epidemiologic investigations of specific health outcomes in communities near environmental sources of hazardous substances.

In keeping with the Superfund mandate to ". . . establish and maintain a national registry of serious diseases and illnesses . . .", we at ATSDR see ourselves as having a direct responsibility under CERCLA to participate with CDC and others in developing disease surveillance or tracking systems, particularly for diseases with known or potential relationships to hazardous waste and toxic substances. In addition, because of our close working relationship with EPA, we are interested in how to link environmental data bases with developing health tracking data. Although we are very far from a comprehensive system at this point, ATSDR does have some ongoing, albeit limited, efforts underway as part of our Superfund work. These include an epidemiologic study investigating the cause of childhood cancers in conjunction with Superfund sites in four States, and a pilot program to develop health tracking of multiple sclerosis in a number of circumstances where concern about the frequent occurrence of this disease arose in relation to adjacent hazardous waste sites.

But we recognize that more can be done. Mr. Chairman, the public naturally becomes concerned when they see situations such as half of a class of third graders needing to bring asthma inhalers to school, or when persons compare notes about their first diagnosis of multiple sclerosis at a 20-year high school reunion, or when multiple parents within the same neighborhood watch their children suffer from brain tumors and other severe illnesses, or when women who do not smoke and who did everything right during their pregnancy give birth to small or sick babies. Sadly, in a country as large as ours, these unusual occurrences are not so unusual at all. All over the country, citizens turn to their local, State and Federal health authorities and ask what could be causing these and other types of clusters of health problems. In communities near obvious sources of environmental contamination, people understandably worry that somehow environmental pollution might be playing a role.

At ATSDR we are committed to doing what we can to address these very real concerns.

- As I've stated earlier, we are working every day at sites around this Nation to address the health concerns of communities affected by toxic exposures.
- We are working with our colleagues at CDC to address the issue of health and disease tracking.
- And, we continue to strengthen our ongoing partnerships with Federal, State and local agencies, which is integral to answering these questions.

Mr. Chairman, on a personal note, I started my professional career as a pediatrician at the Centers for Disease Control in 1972, and my first investigation was of a leukemia cluster in Elmwood, Wisconsin. I did several more such investigations over the next 18 months, none of which revealed an obvious cause for the clusters. However, my fourth or fifth such investigation was of 4 cases of liver cancer in a factory which turned out to be the first reported cases of vinyl chloride induced liver angiosarcoma in polyvinyl chloride polymerization workers. This subsequently led to much improved and safer working conditions for the entire industry worldwide. I have seen how agonizingly frustrating this work can be; but I also feel that if we are in the mode of carefully scrutinizing health data, then we will be positioned correctly to detect new problems when they arise.

Mr. Chairman this concludes my testimony. I will be happy to answer any questions that you or members of your committee might have.

STATEMENT OF THOMAS SINKS, PH.D., ASSOCIATE DIRECTOR FOR SCIENCE, NATIONAL CENTER FOR ENVIRONMENTAL HEALTH, CENTERS FOR DISEASE CONTROL AND PREVENTION, DEPARTMENT OF HEALTH AND HUMAN SERVICES

Good morning, Mr. Chairman and members of the committee. I am Dr. Thomas Sinks of the Centers for Disease Control and Prevention (CDC) where I am the Associate Director for Science within the National Center for Environmental Health. I am pleased to review CDC's assistance to the Nevada State Health Division's investigation of acute lymphoblastic leukemia (ALL) in Fallon, Nevada. I will discuss how CDC provides the technical assistance and infrastructure in responding to disease investigations, and briefly characterize cancer clusters, the roles of State and Federal agencies in investigating them, and coordination between agencies.

I want to begin by assuring the parents of Fallon, and all parents whose children are diagnosed with cancer, that we at CDC are deeply concerned about the health and well being of children. We are encouraged by the wonderful improvements in the clinical treatment of ALL—today 80 percent of children with ALL will have healthy and productive lives. However, we need to identify the causes of ALL to prevent it and decrease the number of children who suffer from it.

State health departments are on the front line in responding to cancer clusters and other disease clusters, and the CDC plays an important role in providing infrastructure and technical assistance. CDC has a close relationship with our sister agency ATSDR (the Agency for Toxic Substances and Disease Registry) and we coordinate our response to cancer and disease cluster inquiries. Cancer and disease cluster activities at CDC have included field investigations, convening a national conference on the clustering of health events, publishing recommendations for the epidemiologic investigation of disease clusters, and providing technical assistance to health departments involved in specific cluster investigations.

Last month CDC released the first National Report on Human Exposure to Environmental Chemicals, an important new research tool that will provide better information on levels of exposure to environmental chemicals, and over time what these levels mean for public health. Using a technology known as biomonitoring, CDC's environmental health laboratory measures chemicals directly in blood and urine samples rather than estimating population exposure using measurements from air, water or soil samples. By showing what the U.S. population is exposed to under "normal conditions," the report can become a vital tool for epidemiologists to compare blood and urine levels of chemicals in suspected disease cluster areas to the baseline exposure data for the general population. We will be using this same type of biomonitoring technology to assist the Nevada State Health Department in investigating these cases of ALL. We are working to be able to transfer this technology to State public health laboratories so that they can do their own biomonitoring of chemical exposures.

TECHNICAL ASSISTANCE TO NEVADA

CDC has worked with the Nevada Health Division since July 2000, providing technical assistance in each phase of the investigation. CDC helped plan, and participated on, the expert panel review last February 15th. The panel commended the Nevada Health Division's work and recommended six followup steps; four of which involve active assistance from CDC and ATSDR. I recently met with CDC and ATSDR staff to coordinate our agencies' assistance to the State. CDC and ATSDR will help the State complete: (1) a cross-sectional exposure assessment of environmental contaminants in drinking water, house dust, and the blood and urine of county residents, (2) an assessment of environmental contaminants and possible pathways leading to human exposure, (3) the establishment of a tissue bank for future research into the causes of ALL, and (4) the continuation of the expert panel to provide independent review of the investigation.

CANCER CLUSTERS

Cancer clusters provide opportunities as well as challenges for public health agencies. The phrase "cancer cluster" implies that more cancer cases or cancer deaths have occurred in a specific geographic region than expected. A cancer excess may, or may not, be the result of an exposure to a unique carcinogen.

Public health agencies are challenged by cancer clusters because of the number of public inquiries—probably thousands of perceived cancer clusters have been reported. For example, more than 2000 published newspaper articles from January 1990 to January 2000 contained the words "cancer cluster." A survey of 41 State health departments found they registered about 1900 cancer inquiries in 1996 alone. An additional challenge is the unrealistic expectation placed upon public health offi-

cials to identify and remove the cause of each cancer cluster. In reality, 85 to 90 percent of evaluated cancer cluster inquiries do not find an excess number of cancer cases. Although 10 to 15 percent of cancer clusters have involved an excess in cancer cases, only a handful led to important discoveries of preventable causes of cancer.

Cancer clusters can provide an opportunity for cancer prevention and control. Cancer education and screening programs are important tools in the fight to prevent and control cancer and can be used effectively in some cancer cluster circumstances. Scientific investigations of cancer clusters and local environmental concerns, however, may take years to complete and the findings are often inconclusive. If a cancer cluster and hazardous levels of an environmental contaminant coexist, removal of the health hazard seems prudent, regardless of its role in causing cancer.

CDC AND STATE ROLES IN RESPONDING TO CANCER CLUSTERS

At CDC, three centers are involved in responding to cancer clusters. Our National Center for Chronic Disease Prevention and Health Promotion supports statewide, population-based cancer registries through the National Program of Cancer Registries (NPCR.) Cancer registries and their use to identify and monitor cancer trends are an essential tool for evaluating cluster inquiries. The Nevada Cancer Registry (NCR) received more than $1,480,000 from CDC's NPCR from 1994 through 2000 to track cancers including ALL. CDC's National Center for Environmental Health conducts exposure assessments and epidemiologic studies that evaluate how people are exposed to environmental hazards and identify preventable environmental causes of cancer. The CDC's environmental health laboratory measures known and suspected cancer causing agents in human blood and urine. CDC's National Institute for Occupational Safety and Health (NIOSH) addresses exposures to cancer causing agents in the workplace by conducting laboratory science and epidemiological investigations in fields like toxicology and immunology. NIOSH also responds to requests from employers, employees, and other government agencies for investigations involving possible work-related cancer. Finally, CDC's sister agency ATSDR plays a critical role in responding to clusters as you will hear from ATSDR Assistant Administrator, Dr. Henry Falk.

ENHANCING CANCER CLUSTER EVALUATIONS

Three key ingredients needed for an adequate response to public concerns about cancer clusters are sufficient infrastructure, assurance of scientific credibility, and coordination between agencies. State infrastructure requirements include cancer registration and tracking, cancer prevention and control, and a mechanism for rapidly identifying hazardous levels of environmental contaminants; recommendations supported by The Pew Environmental Health Commission. A significant advance in children's cancer surveillance is taking place with the consolidation of pediatric cancer specialists within the Children's Oncology Group with funding from the National Cancer Institute. Scientific credibility requires that experts from many fields work together. Independent review by expert panels also ensures the credibility of State investigations. Scientific credibility could be further enhanced by developing investigative priorities from hypotheses for why certain cancers might cluster. A work group to establish such investigative priorities is needed.

Coordination between agencies is essential. The successful collaboration in Fallon, Nevada involves multiple departments within the State, the Federal Government, and academic institutions. Agencies involved from the Department of Health and Human Services include not only CDC, but also ATSDR and the National Cancer Institute. Representatives of the Fallon Naval Air Station have also volunteered their complete cooperation in the investigation.

CDC is currently in the process of assessing the nation's public health infrastructure and its needs. CDC has convened an agency-wide workgroup, along with ATSDR, to review and respond to the Pew Environmental Health Commission Report. This report recommends the strengthening of Federal, State and local public health capacity to tackle environmental health problems and establish a Nationwide Health Tracking Network to identify and track chronic disease and potential environmental factors. CDC is working to establish a nationwide laboratory network to assist communities in evaluating toxic emergencies and human chemical exposure. This will help communities monitor disease trends and evaluate whether these are linked to exposures in the environment. In addition, CDC has recently released a report focusing on a broader perspective of the current status of public health infrastructure. The report is entitled *Public Health's Infrastructure: Every health department fully prepared; every community better protected*, and is available on CDC's website. Assessment of the nation's public health infrastructure will help us to determine how to best target resources to build capacity at the State and local level,

and will enhance our ability to interact with communities to address their local public health needs.

I applaud the people of Fallon for their positive response during this stressful time. Strong communities are strengthened by people drawing together to help one another through difficulty. I assure you that the CDC will continue to collaborate with our Federal partners and assist the State of Nevada. Thank you, Mr. Chairman and members of the committee, for the opportunity to testify before you today. I would be happy to answer any questions you might have.

STATEMENT OF RAMONA TROVATO, DIRECTOR, OFFICE OF CHILDREN'S HEALTH PROTECTION, ENVIRONMENTAL PROTECTION AGENCY

Good Morning. My name is Ramona Trovato and I am the Director of the Office of Children's Health Protection at the U.S. Environmental Protection Agency. Thank you for inviting me here today to discuss our response to environmentally-related health problems. It is deeply distressing to know that a number of children in this community have developed leukemia. Even one child with leukemia is one too many.

The Environmental Protection Agency's mission is to protect human health and safeguard the environment. We protect human health by limiting peoples' exposure to contaminants in the air we breathe, the water we drink, and the food we eat. The Environmental Protection Agency works through the States to protect public health. About half of the Environmental Protection Agency's budget is sent directly to the States for their use in environmental and public health protection. In fiscal year 2001, the Environmental Protection Agency is providing $3.5 billion to the States for all environment programs. This same year, Nevada received more than $6 million in clean water State revolving funds and $7.8 million for drinking water State revolving funds.

The protection of human health requires a partnership at the local, State and Federal level. I would like to begin by addressing the government's response to environmentally-related health problems through some past examples, and then talk about how we can address some of the issues facing your community. Given the unique roles of each of the different agencies, it is essential for environmental officials at all levels of government to work with their public health counterparts to address the environmental health needs of our citizens.

HOW DOES THE ENVIRONMENTAL PROTECTION AGENCY RESPOND TO CANCER CLUSTERS

We currently address potential cancer clusters through an informal agreement among government agencies. Through this partnership, each agency brings their particular expertise to the investigation as needed. The current process is as follows: State public health departments perform the initial phases of cancer cluster investigations according to defined protocols. If further investigation is warranted, the Centers for Disease Control and Prevention may be asked to provide technical assistance to States on a case-by-case basis. Additional assistance may be provided by the Agency for Toxic Substances and Disease Registry and the National Cancer Institute.

• If findings indicate a suspected environmental linkage, the National Institute of Environmental Health Sciences, and/or the Environmental Protection Agency may be consulted.

Through its participation in this partnership of Federal, State, and local agencies, the Environmental Protection Agency has a long history of dealing with environmentally-related health problems in communities. I'd like to give you a specific example of how the Environmental Protection Agency has partnered with other agencies to address a real problem.

Case Study: Community Confronts Childhood Cancer

In 1996, due to public concerns about high rates of certain types of cancer among children in the Dover Township/Toms River area of New Jersey, a study was conducted by the Agency for Toxic Substances and Disease Registry and the New Jersey Department of Health and Senior Services. They found a previously unidentified contaminant in two drinking water wells. These agencies then asked for the Environmental Protection Agency to identify the contaminant. Through a cooperative effort led by the Environmental Protection Agency's Las Vegas laboratory, the contaminant mixture, called SAN trimer, was identified. This contaminant was found in low part-per-billion levels in the two wells already known to have been impacted by a local Superfund site. The existing treatment system at these wells was not effective at removing the contaminant. Because this area is part of a Superfund site, the Environmental Protection Agency directed Union Carbide, the site's potentially

responsible party, to install a carbon treatment system on the two contaminated wells to supplement the existing treatment. The new carbon treatment system removes the contaminant to non-detectable levels. The Environmental Protection Agency, with the National Institute of Environmental Health Sciences, is overseeing long-term chronic studies to determine if this contaminant causes cancer.

HOW DOES THE ENVIRONMENTAL PROTECTION AGENCY RESPOND TO SUPERFUND SITES

Working under the mandate of the Superfund legislation, the Environmental Protection Agency works closely with the Agency for Toxic Substances and Disease Registry to perform the necessary activities to respond to environmental hazards and associated health threats in communities. The Agency for Toxic Substances and Disease Registry performs health assessments around Superfund sites, as well as in communities upon request. The Agency for Toxic Substances and Disease Registry's public health assessment process determines those potentially exposed and makes recommendations to reduce exposure and mitigate potential health outcomes. The Environmental Protection Agency responds to these recommendations and intervenes where possible to stop exposures. Communities can petition the Agency for Toxic Substances and Disease Registry for a community health assessment and can petition the Environmental Protection Agency to request a preliminary assessment. If the preliminary assessment indicates a problem, then the Environmental Protection Agency can take immediate action and begin the process of cleanup.

Case Study: Citizen Complained of Strange Odor—Methyl Parathion (Pesticide)

In 1994, a resident of Lorain County, Ohio, was worried about a strange odor in his home. He called the local State agriculture department to find out what it was and what to do about it. The citizen had recently had his home sprayed to eliminate cockroaches and other pests. State sampling revealed the presence of methyl parathion in his home. Methyl parathion is a highly potent pesticide used on cotton and food crops. It was registered only for outdoor use, not for indoor use. The State agricultural representative turned to the Environmental Protection Agency, who investigated the illegal indoor application of methyl parathion and found an unlicensed applicator had been spraying inside homes and distributing bottles of this pesticide to homeowners. With help from the media and churches, citizens were alerted and people who had their homes treated were asked to come forward and have their homes tested for methyl parathion. The Environmental Protection Agency's Superfund program, with the Agency for Toxic Substances and Disease Registry, provided $21 million and expertise to decontaminate and restore 233 homes in Lorain County. Similar incidents turned up in Michigan, Mississippi, Louisiana, Tennessee, Illinois, Arkansas, and Alabama. After contaminating hundreds of homes in six States, the individuals responsible for the problem were identified, prosecuted and convicted.

In these cases, the Environmental Protection Agency and the Agency for Toxic Substances and Disease Registry issued a joint public health advisory about the problem, produced public outreach and educational material, and coordinated a Federal response. The two agencies also worked together on procedures for testing the presence of methyl parathion residues in homes and in the urine of residents, developed criteria for relocation of residents and procedures for cleanup of contaminated homes. The Agency for Toxic Substances and Disease Registry is still following the exposed children to determine residual health problems.

On a final note, the Environmental Protection Agency canceled the use of methyl parathion on many food crops because it was found to present acute dietary risks, especially in children.

HOW DOES THE ENVIRONMENTAL PROTECTION AGENCY RESPOND TO WATERBORNE ILLNESS?

The Environmental Protection Agency also responds to cases of illness that are believed to be associated with contaminated drinking water. The Environmental Protection Agency works through a formal agreement with other agencies to resolve the problem that caused the illness. The State health department responds first and if they need assistance, they call on the Centers for Disease Control and Prevention. The Centers for Disease Control and Prevention may then request consultation or participation by the Environmental Protection Agency in detecting, monitoring, sample testing, and providing engineering assistance for water supply pathways or water treatment plants.

Drinking Water Infrastructure: Meeting the needs of small communities

The Environmental Protection Agency also helps communities address public health threats through the Drinking Water State Revolving Loan Fund, established

to provide States with a continuing source of financing for drinking water infrastructure projects. Last year, the Environmental Protection Agency provided more than $880 million to States to finance the costs of infrastructure improvements. The program places a particular emphasis on the needs of small systems that serve 10,000 or fewer residents. Congress required that at least 15 percent of the funds be provided to small systems.

Case Study: Cryptosporidium A waterborne intestinal parasite

In 1993, hospitals and schools in Milwaukee, Wisconsin began reporting widespread absenteeism among employees and students due to gastrointestinal illness. The medical community and local health departments, together with the Centers for Disease Control and Prevention recognized that this outbreak was too widespread for a food-borne illness. The Milwaukee public water system was contacted and high levels of turbidity were identified in the drinking water. These high levels were estimated to have lasted for 16 days before the problem was identified and corrected. It was later estimated that during the outbreak, Cryptosporidium levels in treated water may have exceeded 100 oocytes per 100 liters. During that time, an estimated 400,000 individuals in Milwaukee became ill from Cryptosporidium and at least 50 cryptosporidiosis-associated deaths were reported.

Scientists and water treatment engineers from the Environmental Protection Agency and the Wisconsin Department of Natural Resources provided assistance by evaluating and correcting problems with the treatment plant. Together the team identified that the problem arose from a change in treatment practices, lack of familiarity with these new practices, unusually high levels of Cryptosporidium in the source water, and delays in correcting the problem when it first occurred. Together with local, State and Federal Government agencies, experts restored the quality of the drinking water and introduced additional safeguards to help ensure the future safety of drinking water for Milwaukee residents. What else are Federal agencies doing to address environmental health concerns?

Since 1997, the Environmental Protection Agency, the Department of Health and Human Services, the Department of Housing and Urban Development, and many other Federal agencies have joined together to focus on environmental health threats to children. The interagency group first identified those diseases and disorders that affect children's health and may be associated with an environmental contaminant. The diseases and disorders selected were: asthma; developmental disorders, including lead poisoning; and childhood cancer. Asthma affects about five million children and is the leading cause of hospitalization in children. Developmental disorders are the leading cause of lifelong disability. Childhood cancer is the leading cause of disease-related mortality in children ages 1 to 14. Each year, more than 8,000 cases of childhood cancer are diagnosed.

The specific causes and confluence of factors that contribute to asthma, developmental disorders, and childhood cancer are generally unknown. Therefore, the decision was made to focus on research to help us better understand the influences, mechanisms and interactions of environmental factors that contribute to childhood disease. Where we have sufficient knowledge to act, we have developed strategies to address environmental health concerns. The national asthma strategy was launched in January 1999; the national lead strategy was released in 2000; and the Environmental Protection Agency and the Department of Health and Human Services have jointly funded research centers to investigate children's environmental health concerns. (An additional center is funded by the Environmental Protection Agency). Five of the nine centers conduct research related to asthma; the remaining four conduct research on development disorders. Also, the National Cancer Institute is conducting research into childhood cancer and developing a national registry of all children with cancer.

Asthma Strategy

There is an epidemic of asthma in the United States. Nearly 1 in 13 school-aged children has asthma. Asthma is one of the leading causes of school absenteeism, accounting for more than 10 million missed school days each year. Asthma is the leading cause of hospitalization for children. Asthma symptoms that are not severe enough to require a visit to the emergency room can still prevent a child from living a fully active life.

The Environmental Protection Agency and the Department of Health and Human Services developed a strategy that focuses on research and public health preventive programs. Twenty-four million dollars was provided in fiscal year 2000 to expand the Environmental Protection Agency's research and public information programs to address indoor and outdoor asthma triggers. This effort is closely coordinated with the Department of Health and Human Services program which has committed $128

million to address asthma. We've just begun to work with State environmental and health departments to address this epidemic.

LEAD STRATEGY

Another collaborative effort on behalf of the Federal Government is the Federal strategy to eliminate lead paint hazards in homes where children under age six live. Childhood lead poisoning is entirely preventable, yet today it remains a serious environmental health risk facing children. Lead is highly toxic to young children and can cause reduced intelligence, impaired hearing, and behavioral difficulties, and at higher levels can harm a child's internal organs. In the United States, almost one million children under the age of six have toxic levels of lead in their bodies. The strategy attempts to decrease this number to virtually zero in 10 years. It coordinates measures in many Federal departments and agencies aimed at preventing lead poisoning by:

- Acting before children are poisoned by eliminating and preventing residential lead paint hazards;
- Identifying and caring for children already poisoned;
- Conducting research to drive down remediation costs; and
- Continuing surveillance and monitoring programs.

The Department of Housing and Urban Development provides grants to cities and States to address lead paint hazards in low-income housing.

LONGITUDINAL COHORT STUDY

Last year, Congress enacted the Child Health Act of 2000 that authorizes the National Institute for Child Health and Human Development to conduct a longitudinal cohort study to examine the impact of environmental pollutants on children. This long term study will evaluate the link between environmental factors and developmental disorders, from conception through early adulthood. It will help the Federal Government understand how the environment, family, and society interact with the genetic makeup of the developing fetus and child. The goal is to identify specific areas where prevention, intervention, and treatment will make a difference for America's children. As the Framingham study provided us much of what we know about heart disease, this study could be the watershed in children's environmental health protection. It will require the dedicated and determined effort of all our partners in the environmental and health communities to complete this effort.

HOW CAN EPA HELP

EPA has scientific and technical experts throughout the country experienced in environmental monitoring, sampling, laboratory analyses, modeling, remediation and emergency response. We can work closely with the citizens of Fallon, the Agency for Toxic Substances and Disease Registry, the Centers for Disease Control and Prevention, and the State of Nevada to conduct environmental assessments. Our assessment activities could include environmental testing, surveying industrial, mining, and waste disposal activities in and around Fallon, searching records to understand historical uses of the area and inspecting potential release sites.

Moreover, EPA has more than 40 hot lines and websites, that provide assistance on a variety of topics, from acid rain to safe drinking water. In addition, the EPA has a number of websites that provide information for professionals and families regarding a wide variety of environmental topics including pesticides and children's environmental health.

In addition, the Agency for Toxic Substances and Disease Registry and the Environmental Protection Agency jointly fund the Pediatric Environmental Health Specialty Units in each of the 10 regions. The pediatric units provide a clinical referral resource for health care providers and parents. Health care professionals diagnose and evaluate health threats associated with exposure to hazardous substances. In addition, children can be seen at these units by health care professionals. These units serve an important role in the health care community due to their expertise in recognizing environmental health problems and treating children with these problems. The closest site to Fallon, NV is located in San Francisco at the University of California. This pediatric unit can be reached at (415) 206–4320.

CONCLUSIONS

Thank you for allowing me to address the committee and the community of Fallon. I am so sorry that your children are suffering. I hope that together we can make a difference. I have a few suggestions:

- Replicate the waterborne disease response model, which I mentioned earlier, to address other environmental health problems.
- Bolster the State and local public health infrastructures to monitor and respond to environmental health threats and put in place preventive health programs that alert us to problem areas that are likely to occur and to take the appropriate actions before communities suffer.
- Strengthen the partnerships among environment and health agencies at Federal, State, and local levels.
- Establish a national health tracking system for chronic diseases such as asthma, birth defects, cancer and developmental disorders, to ensure a rapid response to emerging environmental related health concerns.
- Conduct the national longitudinal cohort study on environmental factors affecting child health.

Children are our future and we should do everything in our power to protect them.

STATEMENT OF DR. SHELLEY HEARNE, EXECUTIVE DIRECTOR, TRUST FOR AMERICA'S HEALTH

Mr. Chairman, Senator Reid, and members of the committee, thank you for the opportunity to come to Nevada to provide real perspective to our nation's ability to respond to health crises like the pediatric leukemia cluster you are facing here in Fallon.

My name is Dr. Shelley Hearne and I serve as the executive director of the Trust for America's Health—a new nonprofit health advocacy organization committed to preventing disease and protecting the health and safety of our communities. I am very proud to have former Governor Lowell Weicker, Representative Louis Stokes, and Chairman John Porter, along with many other national leaders in public health serve on our Advisory Council.

By way of background, I am an environmental health scientist—serving for almost 20 years in government, non-profits and as a faculty of the Johns Hopkins School of Public Health. Most recently, I was the executive director of the Pew Environmental Health Commission—a blue ribbon independent panel charged with developing recommendations to improve the nation's health defenses against environmental threats.

Let me start by being candid. Our public health service is falling short in its duty to watch over the safety and health of the Americans, particularly when it comes to chronic diseases that may be associated with environmental factors.

Chronic diseases are responsible for 7 out of 10 deaths in this country. More than a third of our population, over 100 million men, women and children suffer from chronic diseases. These diseases cost our citizens and government, $325 billion a year. By 2020 chronic diseases are estimated to afflict 134 million Americans and cost $1 trillion a year. And the CDC estimates that 70 percent are preventable.

But our Federal Government is not actively pursuing how to prevent this epidemic of chronic diseases.

As a Nation, we have been increasing our research into how to treat disease. As a result, we have some good news here. More children with leukemia survive today than ever before. But there is bad news. The rates of childhood leukemia have been steadily rising for the past two decades. As a Nation, we have not invested in preventing chronic diseases.

This health crisis in Fallon is a tragedy. My heart goes out to these families, this community. But as a health scientist, I grow more angry as I watch this story increasingly repeated in communities all across the country. In 1997, there were almost 1,100 requests by the public to investigate suspected cancer clusters. Many of these are preventable diseases, preventable tragedies and our public health resources are insufficient to effectively respond to these challenges.

Let me give you an example from my home State of New Jersey. Parents in Brick Township complained to politicians and health officials for years about a feared autism cluster in their community. But health agencies could not even confirm the cluster for years because they lacked the most basic investigative tools. New York has a similar story. In Elmira, New York, the State health officials have been investigating an unusually high incidence of cancer among children who attended the Southside High School. Fifty-three (53) cases of cancer have been reported from the 7,500 current and former students who attended the high school since it opened in 1979. Thirteen of the cases were reported in the past 3 years. The high school was built on land that has served as an industrial site since the Civil War. No one knows why this is happening.

Even though we know about the increasing numbers of chronic disease clusters and the staggering human and financial toll they have on our country, we have no systems in place to detect chronic disease clusters nor do we have the capability to respond to these health crises. Our Federal, State, and local agencies only coordinate tracking and responding to infectious diseases such as polio, yellow fever and typhoid. Diseases that a national tracking and response system helped to eradicate back in the late 1800's.

Over a century later, we never modernized our public health system to respond to today's health threats. As a result, we are hamstringing our health specialists from finding solutions and effectively taking action—regardless if it's childhood leukemia in Fallon or a nationwide asthma epidemic.

Let me give you some examples of our scattered State health tracking systems from the State of Nevada.

• Even though birth defects are the No. 1 cause of infant mortality, Nevada does not track birth defects. The Pew Commission gave Nevada and 16 other States an F in its report, "Healthy from the Start" which was released in late 1999.

• Nevada does not track developmental diseases such as cerebral palsy, autism and mental retardation even though the National Academy of Science estimates that 25 percent of these diseases in children are caused by environmental factors.

• Even though studies have shown autoimmune diseases like Lupus to be increasing, Nevada does not have a system to track these diseases.

• Nevada's cancer registry has been severely neglected for years. It is the only State that charges hospitals to report cancer cases—a perfect formula to ensure poor participation.

Unfortunately Nevada is not unusual, it is the norm. This is because our Federal Government has failed to establish a comprehensive national approach to tracking and responding to chronic disease.

The Pew Environmental Health Commission based out of the Johns Hopkins School of Public Health studied our nation's capacity to identify and respond to chronic disease clusters for 2 years and proposed creating a nationwide Health Tracking Network to solve this problem.

The Nationwide Health Tracking Network is based on four principles: (1) building a coordinated system of tracking chronic diseases and associated environmental factors; (2) providing the resources and training to local health departments to analyze the data; (3) immediately responding to health problems identified through the system; and (4) providing the national leadership to coordinate health and environmental activities throughout the Federal Government so that these programs do not operate in isolation of one another.

The Nationwide Health Tracking Network consists of five components:

1. *Establishing essential data collection systems.*—The first component builds on existing health and environmental data collection systems and establishes data collection systems where they do not exist. The Network will coordinate with the local, State and Federal health agencies to collect this critical data.

In all 50 States, the Network would track:

• Asthma and other respiratory diseases;
• Developmental diseases such as autism, cerebral palsy, and mental retardation;
• Neurological diseases such as Alzheimer's, multiple sclerosis, and Parkinson's;
• Birth defects; and
• Cancers, especially in children.

The Network also would track exposures to:

• Heavy metals such as mercury and lead;
• Pesticides such as organophosphates and carbamates;
• Air contaminants such as toluene and carbamates;
• Organic compounds such as PCB's and dioxins; and
• Drinking water contaminants, including pathogens.

Building upon the existing systems for infectious diseases, the Federal Government will establish the standards for the health and exposure data collection necessary to create uniformity throughout the system. With Federal resources such as funding, training and lab access, State and local public health agencies will collect, report and analyze the data.

2. *Creating an Early Warning System.*—The second component is an Early Warning System that would immediately alert communities of health crisis such as lead, pesticide and mercury poisonings. The existing system of local health officials, hospitals and poison centers that alert our communities to outbreaks like food illness and the West Nile virus would also alert our communities to these health crises.

3. *Improving response to chronic disease emergencies.*—The third component consists of improving our response to identified disease clusters and other health crises. The Network would coordinate Federal, State and local health officials into rapid

response teams to quickly investigate these health problems, providing the teams with trained personnel and the necessary equipment.

4. *Addressing unique local health problems.*—The fourth component is a pilot program consisting of 20 regional and State programs that would investigate local health crisis and clusters that are currently not part of the Nationwide Health Tracking Network. These programs would alert the public and health officials to new developing disease clusters outside of the Nationwide Health Tracking Network. These pilots programs also would serve as models for tracking systems for inclusion in the Network.

5. *Creating community and academic partnerships.*—The fifth component establishes relationships with five Academic centers and with our communities. Our community relationships would ensure that the tracking data is accessible and useful on a local level, and our research relationships would train the work force, analyze data, and develop links between the tracking results and preventive measures.

[The background and basis for this Network and other Commission findings and recommendations are attached as part of the written testimony. These are also available on the website at *http://pewenvirohealth.jhsph.edu* or *http://healthtrack.org*]

This Network would provide our communities, scientists, doctors, hospitals and public health officials with missing data on where chronic diseases are clustering and associated environmental factors that would enable us to develop prevention strategies. Over 30 key health organizations have endorsed this recommendation, ranging from Aetna US Health Care to the American Cancer Society to the American Academy of Pediatrics to the Association of State and Territorial Health Officers (ASTHO).

The American Chemistry Council supports the concept, noting that ". . . data generated by a national tracking program can shift the focus from debate and speculation about disease trends to intervention and prevention based on scientific evidence."

Developing prevention strategies are critical to reducing the $325 billion a year Americans spend on chronic diseases. In less than 15 years, the estimated cost of chronic disease is predicted to rise to $1 trillion. The estimated cost of the Network is about $275 million or less than 1 dollar per every man, woman and child.

These data will allow us to spend our limited treatment and research dollars more effectively by identifying which chronic diseases are increasing. We have doubled our research dollars in the National Institutes of Health, yet these scientists do not have even the most basic information about why these diseases occur, where they strike, whom they choose as their victims, and how to take action to prevent future clusters.

Without a Network, we will remain in the dark; still unable to answer these questions.

The most cost effective use of tax dollars today would be to invest in preventing the leading killers in this country. And the American public agrees. The American public is so concerned about this issue that 63 percent feel that public health spending is more important than cutting taxes. Seven out of ten registered voters (73 percent) feel that public health spending is more important than spending on a national missile defense system.

A recent public opinion poll by Princeton Survey Research Associates revealed that nine out of ten (89 percent) registered voters support the creation of a national system.

Most local health departments face declining funding, inadequate training for staff, limited or no laboratory access, and outdated information systems. CDC and ATSDR have not been able to adequately help. For instance, there is no Federal funding for an environmental health specialist or even chronic disease investigator in Nevada. This is true for almost all States. Nor could CDC or the Agency for Toxic Substances and Disease Registries (ATSDR) give Nevada written guidance, standards or protocols on how to investigate this childhood cluster. The health agencies have never developed a concrete response program to these growing cluster demands.

Due to concerns of Bioterrorism, the CDC is taking many steps toward developing a public health infrastructure including upgrading computer and communications systems for collecting and sharing infectious disease data among local public health departments. We could simultaneously build on these initiatives and enhance these efforts to ensure a nationwide strategy for chronic disease prevention. These are the diseases that Americans are dying from today, not tomorrow's theoretical threats.

On a Federal level, there are a few programs that relate to chronic diseases, but do not track and respond to the chronic disease clusters. The irony is the Administration's proposed budget recommends severe cuts for the nation's chronic disease

prevention programs. We need to be going in the exact opposite direction. Health defense should be the country's No. 1 commitment.

Who is guarding our health? The answer is that the public health service has fallen short of its duty—lacking the tracking, troops and leadership. This is exactly where our Federal Government is needed—to develop the tracking and monitoring systems, supply the troops and offer the leadership to prevent chronic disease.

To modernize our public health resources so that we can identify clusters before they grow, we must take rapid action to control their spread and find solutions to prevent diseases. CDC must be given the direct mandate to aggressively respond to communities' concerns like those in Fallon, with modern tools and health-tracking systems. And Congress must prioritize $275 million per year, less than a dollar per person to make this happen. It is just a tenth of 1 percent of the overall spending of health care dollars in this country.

Without this type of investment, we will only watch asthma, certain cancers and other chronic disease rates continue to rise. There will be many more Fallons. And that will be the greatest tragedy of all.

SHUNDAHAI NETWORK,
Pahrump NV, April 19, 2001.

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
U.S. Senate,
Washington, DC.

Subject: Fallon Leukemia Cluster

DEAR COMMITTEE MEMBERS: I am writing in response to a request for public testimony concerning factors to consider connection with the Fallon Leukemia cluster. I would like to see this committee carefully consider the role of fire in the disbursal of hazardous materials through the environment, including fire's role in remobilized radioactive isotopes and other contaminates deposited in Nevada as a result of weapons testing. I would request the committee to consider the dangers associated with fire as a remobilizing agent of radionuclides from the Nevada Test Site and other testing ranges in the State.

During the period of above ground testing from 1951 to 1963, radioactive releases from the Nevada Test Site emitted over 12 billion curies of radioactive material into the atmosphere, 148 times as much as the nuclear disaster at Chernobyl. Other pre-1971 nuclear tests released 25,300,000 curies, and from 1971–1988, 54,000 curies were released, including the 36,000 curies from the Mighty Oak accident, which was itself 2000 times greater than the release at Three Mile Island. Over half of all underground tests have leaked radiation into the atmosphere (DOE Report on Radioactive Effluents, 1988). DOE has been out of compliance with Federal and State permit requirements in the areas of air emissions, water releases, and solid waste disposal (DOE Nevada Operations Office Five Year Plan, 1989).

There is contamination in soil, air, ground and surface water. Strong winds, common to this area of Nevada, can carry plutonium-contaminated dust across a large area. Fallout from above ground nuclear tests in the United States and other countries has radioactively contaminated the atmosphere around the Earth. Project Faultless in Hot Creek Valley was found to have caused radioactive contamination in groundwater. According to EPA Publication 520/4–77–016, cumulative deposits of plutonium (Pu–239 and Pu–240) have been found in soil over 100 miles north of the NTS at levels of 790 mg per acre. Plutonium has a half-life of 26,000 years, and plutonium contaminants ingested in microscopic amounts are capable of causing cancer for 200,000 years. There is no cost-effective technology for decontaminating such sites. No surveys have been conducted to determine health effects on Native American or other residents from Nevada Test Site (NTS) releases. Currently the Nuclear Risk Management for Native Communities project is working to answer some of these questions.

It is known that plutonium translocates to specific radiosensitive organs, especially reproductive organs.

During the years of 1999 and 2000, almost 3,000,000 acres of Public Lands in the State of Nevada were subjected to fires, both wild fire and prescribed burns. Fire remobilizes contaminants. Particles are lifted from the ground into the air, then mobilized through environment on wind currents. The particles are resuspended for an indefinite time period, finally redeposit onto the earth. This process creates fallout. As a result of this process, fire can carry containments across the globe.

We understand that the Nevada BLM oversees management of 1,722,330 acres of public lands considered contaminated with UXO, (unexploded military ordinances). BLM lands border NTS (Nevada Test Site), Nellis Bombing and Gunnery Range,

Tonopha Air Force Base, together with the Fallon Range. No one knows the amount or extent of nuclear contamination in the area surrounding the NTS and Nellis Air Force Base which tests depleted uranium (DU) bombs. In 1997 it was estimated that 30 tons of DU had already been deposited in the target area (Draft Environmental Assessment Resumption of Use of Depleted Uranium Rounds at Nellis Air Force Range Target 63–10), a total of 9,500 combat mix rounds (7,900 DU rounds) being expended annually, there.

Depleted uranium or U–238 has an atomic mass of 238. Its half-life is 4.468 billion years (Rokke, 2001). It's natural occurrence is 2.1 parts per million. Uranium is silver white, lustrous, malleable, ductile, and pyrophoric. This makes DU an ideal metal for use as kinetic energy penetrators, counterweights, and shielding or armor. High density and pyrophoric (catches fire) nature are the two most significant physical properties that guided its selection for use as a kinetic energy penetrator.

A study performed at Yucca Proving Grounds found DU residues in all components of the environment, that environmental concentrations varied widely, that corroded DU residues are soluble and mobile in water, that wind dispersal during testing is the prevalent means of dispersal of DU particles, and that an unknown degree of risk was posed to human health by DU in the environment. Moreover, there appears to be no insight into the issue of long-term (100 to 1,000 years and longer). DU forms of both soluble and insoluble oxides. The inhalation of the insoluble oxides presents an internal hazard from radiation if retained in the lungs.

The long-term effects of internalized depleted uranium are not fully known, but the Army has admitted that "if DU enters the body, it has the potential to generate significant medical consequences." Inhaled DU particles or respirable size may become permanently trapped in the lungs. Inhaled DU particles larger than respirable size may be expelled from the lungs and ingested. DU may also be ingested via hand-to-mouth transfer or contamination of water or food supplies. DU, which is ingested, or enters the body through wind contamination, will enter the bloodstream and migrate throughout the body, with most of it eventually concentrating in the kidney, bone, or liver. The kidney is the organ most sensitive to DU toxicity.

More testing of soil and plants needs to be done to determine what radionuclides might be released into the air in a fire, since a fire and its relationship to the resuspension of contaminants has not been the subject of study. Plutonium and radionuclides concentrate in dust, thus higher concentrations are found in the dust sampling than in regular soil sampling. The standard air monitors and surface water samplers usually used are not sufficient to measure submicroscopic particles of plutonium. Further, plutonium contamination is not homogeneous, so simplistic sampling methods are inadequate (John Till, President, Risk Assessment Corp; 2000). Wind-blown particulates must be considered. Debris and gas will go somewhere, but where? Into the water or the soil?

Radiation detection devices that detect and measure alpha particles, beta particles, x-rays, and gamma rays emissions at appropriate levels from 20 dpm up to 100,000 dpm and from .1 mrem/hour to 75 mrem/hour must be acquired to sess the distribution of particles. Standard rad-meters or Geiger counters do not measure these levels.

In order to assess the health risks and damage due to exposure to tritium (radioactive hydrogen), three blood tests must be done. White blood cells must be tested for the presence of micronuclei, indicating the loss of DNA repair processes and leading to increased cancer risk. Red blood cells must be examined for genetic modification of surface glycophorin-A molecules, also indicating DNA damage. A study of Japanese nuclear bombing victims 40 years from the time of the blasts showed DNA codes were still unrepaired. In addition, chromosome painting allows chromosomes to be stained for identification of structural and sequential or numerical abnormalities linked to radiation and chemical exposure, cancer, and inherited diseases.

In addition to the redistribution of containments, we need to consider the effects of fire upon other substances. For example, we must consider chemical reactions which may take place when multiple herbicides are burned together. For instance, one chemical being most often utilized on public lands is Tordon. But Tordon is also called Grazon, and the active ingredient is picloram, better known as Agent White, similar to Agent Orange, and one of several defoliants used in Vietnam. In fact, Agent White (picloram) appeared in 5 of the 15 defoliants used there. Agent White is currently being sprayed by the U.S. on the coca fields in Columbia as part of the drug war. In 1998, Dow Chemical, manufacturer of Agent White (picloram) tried to halt its use, warning that it does not bind well with soil, easily washes into the groundwater and could cause irreparable damage to the Amazon Rainforest. Yet, U.S.G.S. Pesticide 1992 Annual Use Map showed estimated annual agricultural use of Agent White to be less than 0.370 pounds per square mile per year. The map

shows the entire State of Nevada has been exposed. This is a lot, and has probably increased since that time. If it's dangerous to the water and forest areas of Colombia, it is dangerous here in the U.S. The use of Tordon is banned in some countries.

Also commonly used are 2, 4-D which forms poisonous gas in fire. It is on the Hazardous Substance List because it is regulated by OSHA. The chemical is a mutagen (changes the genetic structure), a teratogen causing birth defects, and a carcinogen particularly related to breast cancer. Short term effects of its use include the death of animals, birds, fish, and plants within 2–4 days after exposure. About 91.7 percent of 2, 4-D will eventually end up in water. In 1990, the Clean Air Act announced 2, 4-D as a hazardous air pollutant. Run off vapors can kill non-target plants. Agent Orange was a mix of 2, 4-D and 2, 4, 5-T. Another name for 2, 4, 5-T is Weedar. And both of these chemicals appear on the recommended list of chemicals used on public lands.

Garlon is also known as triclopyr (both names appear separately on the recommended treatment list as if they are different herbicides). Triclopyr's chemical structure is very similar to 2, 4, 5-T. The MSDS sheet includes the following data: Nitrogen oxides, hydrogen chloride, and phosgene may result under fire conditions and NIOSH/MSHA requires approved SCBA and full protective equipment for firefighters. Garlon-treated wood that is burned during forest fires, or in wood stoves at home produces a dioxin, one of the most damaging compounds to living organisms. Garlon is an endocrine disrupter.

It mimics a plant hormone, acting systematically to kill the plant or tree. The hormone that Garlon mimics is perceived by the human body to be estrogen. In women, this may result in breast cancer, miscarriages, infertility, birth defects, and possibly ovarian cancer. In men, it can cause prostate or testicular cancer and reduction of sperm count. It also may aggravate liver and kidney disease. We do not know what the effects of burning multiple pesticides and the full extent of the risk to public health from such events.

I suggest that a more appropriate methodology for determining causation of the Fallon leukemia clusters would use a multidimensional model for analysis. In other words, rather considering singular etiologies, as suggested by Prescott from CDC at the hearings, a more complex multi-factor dynamic process may be in operation. We might hypothesize very generally that exposure to radionuclides such as tritium, plutonium, or DU, might cause mitochondrial damage to cells. In addition to other functions, mitochondria contribute to a sort of "programmed cell-suicide". For example, in certain stages of fetal development, humans have webbed fingers. The mitochondria detect this, and at the appropriate time, seek to destroy the web cells, leaving humans with fully formed fingers. This cell-suicide is necessary.

However, when exposed to an error or to toxins or radionuclides, the mitochondria engage in a process of "unprogrammed cell suicide." Thus, healthy cells are destroyed. Such suicides may lead to destruction of critical elements of immune system function, resulting in cancers, leukemia, and the inability to fight the effects of various viruses and bacteria. The cells may be more vulnerable to effects of exposure to chemicals or pesticides. In addition, adequate production of certain neurotransmitters and hormones might be disrupted leading to diabetes or neurological damage. These medical conditions have been reported as increasing in the general population, and though differing in appearance, may be reflecting a basic underlying cellular assault caused by radiation exposure. I refer you to the work of Guy Brown. Thank you for your thoughtful consideration.

Sincerely,

Dr. Bonnie Eberhardt Bobb.

[Pew Environmental Health Commission Report, September 2000]

COMPANION REPORT ON AMERICA'S ENVIRONMENTAL HEALTH GAP: WHY THE COUNTRY NEEDS A NATIONWIDE HEALTH TRACKING NETWORK

FOREWORD BY COMMISSION CHAIRMAN LOWELL WEICKER, JR.

With the mapping of the human genome, we are on the verge of a new wave of advances in health. With this remarkable achievement, researchers will be able to shed new light on the links between genetic predisposition and such factors as behavior and exposures to pollutants in the environment in order to prevent many of the chronic diseases that today cause so much suffering.

But there is a catch. We must have the basic information about the health of Americans and our environment before we can make the fullest use of this exciting genetic knowledge. The way to get this basic data is to track it—systematically,

comprehensively, on a coordinated basis at all levels from the local community to the Nation as a whole. We have to track what and where the hazards are in the environment, whether people are at risk from exposures to these hazards, and the health of our communities. Our information about environmental factors must run as deep and comprehensive as our knowledge of the genome.

This report examines our current public health response capabilities to environmental threats, and recommends the establishment of a Nationwide Health Tracking Network. The Pew Environmental Health Commission is charged with developing a blueprint to rebuild the Nation's public health defenses against environmental threats. We know there are pollutants entering our air and water each year with suspected or known adverse effects on the health of our communities. What we are limited in knowing if there is a link between that pollution and the increases we are seeing in chronic diseases because we aren't tracking environmental health factors.

We need to gather the facts now. Americans have a right, and the need, to know.

EXECUTIVE SUMMARY

At the dawn of the 21st century, America is facing an environmental health gap. This is a gap in critical knowledge that hinders our national efforts to reduce or eliminate diseases that might be prevented by better managing environmental factors. This is especially true for chronic diseases and conditions, such as birth defects, asthma and childhood cancer, which strike hundreds of thousands of American families each and every year.

What is the environmental health gap? It is the lack of basic information that could document possible links between environmental hazards and chronic disease. It is the lack of critical information that our communities and public health professionals need to reduce and prevent these health problems. While overt poisoning from environmental toxins has long been recognized, the environmental links to a broad array of chronic diseases of uncertain cause is unknown.

The national cost of chronic disease is staggering: 4 of every 5 deaths annually, 100 million people suffering each year and $325 billion in annual healthcare and lost productivity. While our healthcare system is one of the best in the world in treating disease, the environmental health gap is crippling our ability to reduce and prevent chronic disease and help Americans live longer, healthier lives.

The Pew Environmental Health Commission proposes a Nationwide Health Tracking Network to close this critical gap. With a comprehensive tracking network, we can advance our ability to:

- Identify populations at risk and respond to outbreaks, clusters and emerging threats;
- Establish the relationship between environmental hazards and disease;
- Guide intervention and prevention strategies, including lifestyle improvements;
- Identify, reduce and prevent harmful environmental risks;
- Improve the public health basis for policymaking;
- Enable the public's right to know about health and the environment; and
- Track progress toward achieving a healthier Nation and environment.

The proposed Network would be comprised of five key components:

(1) national baseline tracking network for diseases and exposures;

(2) nationwide early warning system for critical environmental health threats;

(3) State pilot tracking programs to test diseases, exposures and approaches for national tracking;

(4) Federal investigative response capability; and

(5) tracking links to communities and research.

Investing in prevention through these five components is estimated to cost the Federal Government $275 million annually—less than 0.1 percent of the current annual economic cost of treating and living with chronic disease—a very modest investment in a healthier America.

THE GRIM PICTURE—AN ENVIRONMENTAL HEALTH AND PREVENTION GAP

Americans today are sophisticated about their health. More of us are asking if there is something in the air, water or diet that could be making us sick. Is it our behavior—or something in our genes? Unfortunately, we are left with too many unanswered questions.

Recently, a major research study found that most types of cancer are not inherited genetic defects, but are explained mainly by environmental factors. Environmental factors include environmental tobacco smoke, toxic chemicals, dietary habits and

viral infections.[1] Despite many years of effort, scientists still are searching for answers about the relationship among the factors in our behavior, genes and the environment that cause disease and disability.

Earlier this year, it was announced that researchers have mapped the human genome, a breakthrough that is expected to open new doors to understanding chronic disease. Scientists will use this emerging genetic knowledge to fight disease. But if we are going to prevent disease, researchers also need more complete information about environmental factors, their effect on people, and the resulting health outcomes. In this way, scientists will have the capability to link genetic and environmental information and could begin to answer our questions about the complex causes and prevention of chronic disease.

Few would dispute that we should keep track of the hazards of pollutants in the environment, human exposures, and the resulting health outcomes—and that this information should be easily accessible to public health professionals, policymakers and the public. Yet even today we remain surprisingly in the dark about our Nation's environmental health.

We have as a Nation invested heavily in identifying and tracking pollutants in the environment, particularly for regulatory and ecological purposes, but only minimally in tracking exposures and the distribution of disease and its relationship to the environment. As a result of decades of neglect, we have a public health system that is working without even the most basic information about chronic disease and potential environmental factors. The Commission found that information on trends in health conditions potentially related to the environment is largely unavailable. Here are a few illustrations of what this environmental health gap means:

- Only four States report tracking autoimmune diseases, such as Lupus, even though there is increasing evidence to believe rates of these diseases are rising and the environmental links remain unknown.
- Despite evidence that learning disabilities have risen 50 percent in the past 10 years, only six States track these disorders and we have no answers about causes or possible prevention strategies. Most States do not track severe developmental disabilities like autism, cerebral palsy and mental retardation. A recent report of the National Academy of Sciences estimates that 25 percent of developmental disorders in children are caused by environmental factors.
- Endocrine and metabolic disorders such as diabetes, and neurological conditions such as migraines and multiple sclerosis, have increased approximately 20 percent between 1986 and 1995, based on surveys by the Centers for Disease Control and Prevention (CDC). Most States do not systematically track these diseases and conditions.
- For most of the United States, there is no systematic tracking of asthma despite the disease having reached epidemic proportions and being the No. 1 cause of school absenteeism. Between 1980 and 1994, the number of people with asthma in the United States jumped by 75 percent. Without prevention efforts that include a strong tracking component, the Commission has estimated that the number of asthma cases will double by 2020.
- Birth defects are the leading cause of infant mortality in the United States, with about 6,500 deaths annually. Since the mid-1980's, rates of low birth weight and pre-term births have been rising steadily despite increased prevention efforts. The causes of 80 percent of all birth defects and related conditions remain elusive even as evidence mounts that environmental factors play an important role. The Commission found that less than half the Nation's population is covered by State birth defect registries, which inhibits our ability to find solutions.

The tracking programs that do exist at the State and local levels are a patchwork because there are no agreed-upon minimum standards or requirements for environmental health tracking. The Commission found different standards, created to meet different objectives or regulatory requirements, and little synchronization in the collection, analysis and dissemination of information. In addition, much of the data that is collected is never analyzed or interpreted in a way that could identify targets for further action. Most of this data is never released to the public.

There is limited ability to take action at the State level without additional resources and leadership from the Federal Government. For decades, State and local health agencies have faced declining resources, with the result that many now face

[1] Published in the July 13, 2000, edition of the *New England Journal of Medicine*, the study examined the medical histories of 44,788 pairs of twins listed in the Swedish, Danish and Finnish twin registries in order to assess risks of cancer at 28 anatomical sites for the twins of persons with cancer. It concluded that genetic factors make a minor contribution to susceptibility to most types of neoplasms, and the environment has the principal role in causing sporadic cancer.

the 21st century with outdated information systems, limited laboratory access, inadequate staff training and an inability to develop viable tracking programs. The Commission's survey of State and local agencies found a critical lack of funding for these activities despite unprecedented public demands.

Environmental tracking for pollutants is crucial, because often the hazards can be removed or abated before they cause harm. But such monitoring is not sufficient by itself. Tracking actual human exposures to hazards in the environment is frequently the missing link between public health efforts to evaluate a risk nationally and the ability to respond to a health threat in a specific community. This should include improving national efforts to track population exposures to contaminants and providing the investigative tools for local health officials.

Finally, there is a national leadership void, resulting in little or no coordination of environmental health activities. As a result, public health prevention efforts are fragmented and too often ineffective at reducing chronic and disabling diseases and conditions.

The CDC and EPA have some basic building blocks of a tracking network in place, but much more needs to be done. Currently 50 infectious diseases are tracked on a national basis. We need a comparable modern network to track chronic diseases and discover the environmental contributions to them.

THE PUBLIC'S EXPECTATIONS

The public understands that we are not doing enough to protect our communities. A recent national survey of registered voters found that the majority are concerned about risks to their health from pollutants in the environment, and believe that government is tracking these hazards and possible links to chronic health problems.[2] When they learn that in reality there is no disease tracking, they are concerned—seriously concerned. Most Americans surveyed say that taking a national approach to tracking environmental health should be a priority of government at all levels.

Without comprehensive environmental health tracking, policymakers and public health practitioners lack information that is critical to establishing sound environmental health priorities. In addition, the public is denied the right to know about environmental hazards, exposure levels and health outcomes in their communities—information they want and have every reason to expect.

At the same time Americans demand a right to know about these hazards, they also expect government to gather health information in a way that protects citizens' privacy. Americans understand the importance of population-based health tracking as well as the need to keep individual health records private. Fortunately, public health agencies have an outstanding track record for zealously guarding the public's confidentiality and privacy. To ensure this continued balance, the Pew Commission established a set of principles for Protecting Privacy and Confidentiality and Our Environmental Health Right-to-Know (listed in the back of this report). The Commission believes that adherence to these principles will enable public health agencies to continue their traditional commitment to the confidentiality of individually identifiable health records without significantly hampering their obligations to the public health.

The Federal Government tracks many things all the time. It knows how many women dye their hair every year (three out of five), but has only rough estimates of how many people have Parkinson's disease, asthma, or most other chronic diseases that cause four of every five deaths in the U.S. each year. We have the right to know more.

THE PEW ENVIRONMENTAL HEALTH COMMISSION'S RECOMMENDATION—A RIGHT TO KNOW OUR ENVIRONMENTAL HEALTH

To fill the Environmental Health Gap, the first step is to establish a tracking capacity for chronic diseases and environmental exposures that also link to hazard data. To this end, the Commission offers the following comprehensive recommendation:

Create a federally supported Nationwide Health Tracking Network with the appropriate privacy protections that informs consumers, communities, public health practitioners, researchers, and policymakers on chronic diseases and related environmental hazards and population exposures. This will provide the capacity to better understand, respond and prevent chronic disease in this country.

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[2] Health-Track is a project supported by The Pew Charitable Trusts through a grant to Georgetown University. The survey, by Princeton Survey Research Associates, was conducted in April 2000 of 1,565 registered U.S. voters and has a margin of error of ±3 percent for results based on a full sample.

This tracking network would be a tiered approach, with a national baseline of high-priority disease outcomes and exposures that allows flexibility at the State and local level for specific concerns. At a minimum, all information would include race, ethnicity, gender, age and occupation. The blueprint for the Nationwide Health Tracking Network involves five components of information and action:

Tier 1: National Baseline Tracking of Diseases and Exposures

This will be a nationwide network of local, State and Federal public health agencies that tracks the trends of priority chronic diseases and relevant environmental factors in all 50 States, including Washington, DC, Puerto Rico and U.S. territories. The information will allow us to identify populations at high risk, to examine health concerns at the State level, to recognize related environmental factors, and to begin to establish prevention strategies.

The Federal Government will have the responsibility to establish minimum national standards for health and exposure data collection. The State and local public health agencies, with Federal support and guidance, would be responsible for the collection, reporting, analysis and response.

As a starting point, the Commission identified certain diseases and exposures that should be collected by all 50 States, based on review of the scientific literature, environmental data, reported health trends and targets identified by public health agencies. These are:

Diseases and Conditions: Birth defects; Developmental disabilities such as cerebral palsy, autism and mental retardation; Asthma and chronic respiratory diseases such as chronic bronchitis and emphysema; Cancer, including childhood cancers; and Neurological Diseases, including Parkinson's, Multiple Sclerosis and Alzheimer's.

Exposures: Persistent organic pollutants such as PCBs and dioxin; Heavy metals such as mercury and lead; Pesticides such as organophosphates and carbamates; Air contaminants such as toluene and fine particles; and Drinking water contaminants, including pathogens.

To translate this information into action will require a revitalization of the public health infrastructure by providing adequately trained health professionals to collect and interpret the data at the local, State and national levels; to respond to concerns and to ensure a healthy environment. The information produced by the network will be widely disseminated and easily accessible—simultaneously protecting both the public's right to know and individuals' privacy.

Finally, all of these efforts will be coordinated and made available to our communities and public health researchers. To ensure the information is accessible and useful in evaluating the progress of disease prevention efforts, a National Environmental Report Card should be jointly developed by CDC and EPA by 2003. It would provide an annual overview of key environmental factors and health outcomes, allowing all interested parties to track progress and shape national goals. It should be adaptable so that State and local agencies can build on this for their own Environmental Health Report Cards.

Tier 2: National Early Warning System

This early warning system would act as a sentinel to allow rapid identification of immediate health problems, including chemical catastrophes. This would build on the existing infectious disease monitoring network around the country by including environmental sentinel exposures and health outcomes. The existing partnership of hospitals, poison centers and public health agencies that make up the tracking network for outbreaks like food and waterborne illnesses and bioterrorism attacks also should identify and track early warning signs of outbreaks of health effects that may result from environmental factors. This would be the first stage in an environmental outbreak response capability. At minimum, the Commission recommends that this should include: Acute sensory irritation such as eye and respiratory problems, Heavy metal poisoning, and Pesticide poisoning.

For example, if a terrorist or accidental event occurred involving misuse or release of toxic chemicals, an early warning system with environmental capacity could quickly recognize the episode, identify the chemical exposure and more rapidly initiate effective treatment and response.

Tier 3: State Pilot Tracking Programs

The Network also would support a coordinated series of 20 State pilot programs in order to respond to regional concerns and test for exposures and disease outcomes that could be tracked on a national level. These pilots would be "bellwethers" for better understanding potential health and environmental problems.

Selecting appropriate health and environmental indicators is essential to the success of a national network. This requires systematic development of tracking meth-

ods that are flexible, practical and adaptable to the unique public health needs of States.

States may be interested in developing pilot tracking capacity for certain disorders, diseases and exposures in order to strengthen the response to local health concerns. For example, there have been increasing concerns about environmental links to attention deficit disorder, lupus and endocrine disorders, such as diabetes.

Pilot programs covering specific health problems also would provide the Network with a broad reach for rapidly addressing many different health concerns, while at the same time testing methods and evaluating the need for broader tracking of certain health problems.

Tier 4: Public Health Investigative Response

Trained public health officials at the Federal, State and local level need to be able to respond to health concerns that are identified through this network. The Federal Government must provide States and localities with the support and capacity to assure a coordinated response to investigate threats linked to the environment.

By developing the capacity to track trends at the national level and conduct investigative surveys anywhere in the nation, the Network would be prepared to respond to outbreaks, clusters and emerging threats. While this is a routine response for infectious outbreaks, we presently lack a similar ability to respond to chronic disease investigations.

There are many needs for a response capacity. For example, the recent National Academy of Sciences study on mercury and its neurodevelopmental effects on children exposed in utero underscored the need to study exposures and health outcomes of pregnant women across America. This capability also would permit quick response at the local level to citizens' concerns about potential problems, such as spontaneous abortions among women who live near hazardous waste sites.

Tier 5: Tracking Links to Communities and Research

The Network would depend on a strong community and scientific foundation to ensure its relevance, effectiveness and vitality.

The public has a right to know the status of our environmental health at the national, State and local level. It is paramount that the Network be grounded in community groups so that local concerns are adequately addressed in the design of the system, that tracking data is readily accessible and that this information is useful for local level activities. To insure this interaction, the Network should support community-based organizations to routinely evaluate the tracking systems with regard to individual and local needs and to ensure dissemination and interpretation of the Network data.

ACTION STEPS NEEDED TO DEVELOP THE NETWORK

To establish this Nationwide Health Tracking Network, the Commission calls on the Administration, Congress, the Secretary of Health and Human Services, and the Administrator of the Environmental Protection Agency to support and implement the following action plan:

- The Administration and Congress should provide funding support within 1 year to develop and establish the Nationwide Health Tracking Network. This should include support and incentives for State and local agencies, healthcare providers, community-based agencies and insurers to become active partners in tracking population health and identifying, treating, and preventing health problems related to the environment. The Commission estimates that the annual cost for a Nationwide Health Tracking Network is $275 million.
- The Administration and Congress should guarantee public access to the Nationwide Health Tracking Network to better understand community environmental exposure and health outcome information. As part of this right-to-know requirement, the EPA, CDC and the Surgeon General should jointly develop a National Environmental Health Report Card by 2003, which will give all Americans an annual overview of key hazards, exposures, and health outcomes in order to gauge progress and shape national goals. The approach should be adaptable to the needs of State and local agencies to facilitate similar report cards at the State and local levels.
- The Secretary of Health and Human Services, in collaboration with the EPA Administrator, should by 2001:
    - Designate a national lead authority for environmental health tracking to oversee development of a nationwide network and coordinate all related health and exposure monitoring activities, including those of EPA, CDC and the Agency for Toxic Substances and Disease Registry (ATSDR); and
    - Establish a Council on Environmental Health Tracking to work with the HHS, EPA and State tracking leadership to set up science-based criteria,

minimum State standards and privacy and confidentiality guidelines for a tiered approach that supports both national priorities and State flexibility.

- Every Governor should appoint an environmental health lead in the State health department.
- CDC/ATSDR should help build State capacity to launch the Network, monitor the data, and respond to potential health concerns by:
  - Placing an Environmental Health Investigator in every State;
  - Expanding the CDC Epidemic Intelligence Service and Public Health Prevention Service to recruit and train public health officers in environmental epidemiology and tracking;
  - Working with the National Association of County and City Health Officials to develop similar leadership capacity at the local level with support and guidance from HHS; and
  - Providing technical resources to local and State public health agencies, including improvement of regional, State and local laboratory capacity to evaluate community exposures and complement State investigative abilities.

THE CASE OF LIBBY, MONTANA

Last November, Federal agencies began investigating what is believed to be the single most significant source of asbestos exposure in the United States. Residents of the small town of Libby, Montana, have watched for decades as neighbors, friends, and loved ones fell ill with respiratory problems. Many died. Townspeople thought it might have something to do with the vermiculite mine that was the town's largest employer from its opening in the 1920's until it was shut down in 1990. But until the Federal health investigation this year, no one knew for certain. As far back as the mid-1950's, State health officials had reported on the toxic asbestos dust in the mine, but no one followed up on possible exposures or health impacts to the town's 2,700 residents.

It turned out that along with vermiculite, the mine also was releasing tons of tremolite, a natural but rare and highly toxic form of asbestos, into the region's environment. It takes 10 to 40 years for asbestos exposure to manifest in chronic, and often fatal, respiratory diseases, including asbestosis, rare cancers and emphysema. Therefore, early intervention as soon as potential or actual exposures were detected could have prevented these long-term harms.

So far, nearly 200 people reportedly have died from diseases connected to the asbestos-tainted vermiculite. Newspapers account that another 400 have been diagnosed with asbestos-related disease, including mesothelioma, a rare and fatal cancer of the lung lining associated with asbestos exposure. Every month, more Libby area residents are diagnosed with asbestos-related diseases. As many as 5,000 people are expected to undergo medical testing for asbestos-related diseases by Fall 2000.

"Active [tracking] of asbestos-related disease might have picked this up much sooner, and started preventive activities 10–20 years ago," said Dr. Henry Falk, administrator of the Agency for Toxic Substances and Disease Registry. In that case, more lives would have been saved and the severity and possible spread of the outbreak reduced.

Now, public health officials have to cope not only with ensuring that Libby residents are protected from this environmental hazard, but also investigating other sites and possible worker exposures around the country where this asbestos-laden vermiculite was shipped, processed and used in large quantities.

Clearly, this case illustrates the tragedy of not tracking the environmental health of our communities. Every year there are towns and cities across the United States where residents are asking themselves, their health officials and elected leaders, why they or their children are getting sick. Until we establish a national tracking network capable of bringing together in a coordinated fashion the information about environmental hazards in the community, the exposures of people, and data on health problems, we will risk having more cases like Libby, Montana.

THE CASE OF PESTICIDES IN MISSISSIPPI

In November 1996, one of the nation's worst and most costly public health disasters involving pesticide misuse was discovered in rural Jackson County, Mississippi. The event in Jackson came on the heels of similar events in Ohio and Michigan.

Initially, health officials became aware of a possible problem when church members reported a noxious odor and yellowed walls in their church after fumigation. Before long, numerous residents began complaining of various symptoms, mainly re-

sembling influenza. Suddenly, officials were facing a possible pesticide threat potentially larger than any in Mississippi's history.

The initial investigation revealed that illegal pest control spraying in homes and businesses had taken place, potentially exposing thousands of residents in the area to methyl parathion (MP), an organophosphate insecticide intended for outdoor use that attacks the central nervous system, causing nausea, dizziness, headaches, vomiting and in severe cases, death. EPA officials began considering relocation of residents and decontamination of homes at what would be a staggering cost.

Fortunately, public health officials had a health-tracking tool that was able to pinpoint who was at immediate risk and allowed for a more targeted, rapid response. Using biomonitoring—the direct measurement of human exposure to a contaminant by measuring biological samples, such as hair, blood or urine—health officials could determine individuals' exposure levels to MP. In this case, biomonitoring allowed scientists to identify the residents who were most at risk and prioritize evacuation and cleanup in the most dangerous situations, not just every house suspected.

Armed with this information, EPA, ATSDR and State health officials were able to implement an effective health defense plan. In Mississippi and Alabama, over 1,700 residents had to be temporarily relocated and nearly 500 homes and businesses had to be decontaminated at a cost of almost $41 million. While no one died or was seriously injured in the short term, many of the early victims were misdiagnosed with the influenza virus—a fact that only underscores the need for a nationwide health tracking network to monitor environmental threats.

A national early warning system for pesticide poisoning might have detected this problem sooner and led to a quicker halt of the illegal pesticide applications in other States. In turn, this would have prevented widespread exposures, and in some cases, evacuations, and higher human and financial costs. This case also points to the importance of another feature of a network—the laboratory resources and other infrastructure to conduct rapid and effective biomonitoring to protect the health of our communities.

THE COMMISSION'S HEALTH TRACKING ANALYSIS

In the 1970's and 1980's, the nation's environmental regulatory infrastructure was built, fueled by the passage of Federal laws aimed at cleaning up the environment. Unfortunately, these same laws failed to support core public health functions of environmental health. More than a decade ago, the Institute of Medicine report, *The Future of Public Health* sounded a warning, saying the Nation had "lost sight of its public health goals" and allowed the public health system to "fall into disarray." With diminishing authority and resources, public health agencies at all levels of government grew detached from environmental decisionmaking, and the infrastructure failed to keep pace with growing concerns about health and environment.

The Commission's study of health tracking found that today, there still is no cohesive national strategy to identify environmental hazards, measure population exposures, and track health conditions that may be related to the environment. Just as important, there is a national leadership void, resulting in little or no coordination of environmental health tracking activities.

The few existing environmental health tracking efforts are a widely varied mix of programs across multiple Federal, State and local agencies. These programs have evolved, often in isolation from each other, to respond to disparate regulatory mandates or program needs. Unfortunately, there are no identifiable linkages between hazard, exposure and outcome tracking, and there is limited coordination in the collection, analysis, or dissemination of information. The combination of lack of leadership, planning, coordination and resources have left important questions about the relationship between health and the environment unanswered. For example:

- Are environmental exposures related to clusters of childhood cancer and autism?
- What are the impacts of pesticide exposure on children's health?
- What proportion of birth defects is related to environmental factors?
- Are changes in the environment related to the dramatic increase in asthma?
- Are adult-onset diseases like Parkinson's and Alzheimer's related to cumulative environmental exposures?
- Are there increases in Systemic Lupus Erythmetosis (SLE) and multiple sclerosis (MS) in communities with hazardous waste sites?
- Are learning disabilities related to environmental factors?
- Is attention deficit disorder (ADD) related to exposures that occur in a child in the womb?
- Are endocrine disrupting pollutants in the environment related to the increasing incidence of breast and prostate cancers?

- How does particulate air pollution increase the risk of death in the elderly?
- What is the relation of diet and lifestyle to chronic disease?

With the exception of childhood blood lead screening, there have been few systematic efforts to track individual levels of exposure to any hazardous substance. CDC and EPA have developed the methodologies for biological and environmental monitoring of a wide range of substances. However, inadequate support and inconsistent funding have restricted their application and availability. These findings were underscored in a recent report of the U.S. General Accounting Office that calls for a long-term coordinated strategy to measure health exposures to pollutants. With the goal of improving the public health response to environmental threats, the Pew Environmental Health Commission conducted an examination of the national capacity for tracking environmental hazards, exposures and health outcomes. The study had the following objectives:

- To examine the existing public health capacity for environmental health tracking;
- To identify the environmental health priorities of the nation's public health agencies;
- To examine the coordination among agencies, healthcare providers and researchers on environmental health tracking efforts; and
- To develop recommendations for implementing an effective national strategy for environmental health tracking.

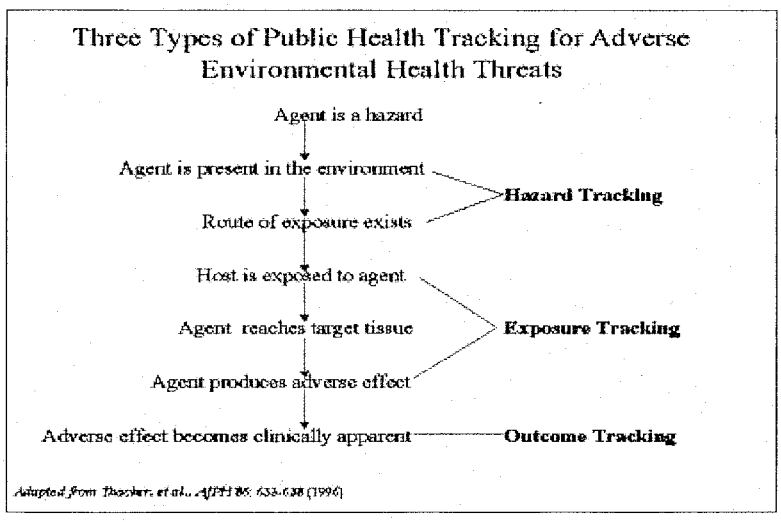
The complete study is available at the Commission's website: *http://pewenvirohealthJhsph.edu.*

A LOOK AT NATIONAL CAPACITY FOR TRACKING

"Tracking" is synonymous with the CDC's concept of public health surveillance, which is defined as "the ongoing, systematic collection, analysis and interpretation of health data essential to the planning, implementation, and evaluation of public health practice, closely integrated with the timely dissemination of these data to those who need to know (Thacker et al., 1988)." Effective environmental health tracking requires a coordinated approach that identifies hazards, evaluates exposures, and tracks the health of the population.

Figure 1 provides a schematic representation of the steps in environmental health tracking.

Figure 1: Environmental Health Tracking



Hazard Tracking

What are the hazards to health in our environment? Environmental hazard tracking identifies potential hazards and examines their distribution and trends in the environment. It is an essential component in prevention strategies, particularly in the absence of definitive knowledge about the health impacts of environmental exposures. EPA and the State environmental agencies have primary responsibility for hazard tracking, which includes networks for data collection on water and air quality, environmental emissions, hazardous and radioactive waste generation, storage, and disposal, and the use of toxic substances and pesticides. These efforts are the foundation of our national environmental protection efforts.

The EPA Toxics Release Inventory (TRI) is an example of an effective and publicly accessible hazard tracking program. The TRI contains data on annual estimated releases of over 644 toxic chemicals to the air and water by major industries. Data are reported as annual total releases by chemical. TRI is an innovative way to provide communities with information about the nature and magnitude of pollution in their neighborhoods. While there are many pollution sources not covered and a 2-year time lag in making the data public, TRI provides the best snapshot of local and national environmental releases of key toxins by major industries.

The Commission analyzed the 1997 TRI data to determine the ranking of 11 categories of associated possible toxicological effects (Table 1)[3]. Substances with potential respiratory effects were released in the largest amount in 1997. Neurotoxicants and skin toxicants were next highest in total pounds released. Actual population exposures to these toxicants are not currently tracked and their relationship to disease is unclear. This approach to hazard tracking provided the Commission with an important starting point for identifying needs for tracking exposure and health outcomes.

Table 1.—Ranking of Toxicants based on 1997 Toxics Release Inventory (TRI)[3]

Types of health effects	Ranking based on 1997 TRI release	Total Air & Water Releases (pounds)
Respiratory	1	1,248,977,984
Neurologic	2	1,211,458,945
Skin or sense organ	3	1,109,718,312
Gastrointestinal or liver	4	1,086,264,404
Cardiovascular or blood	5	823,375,664
Developmental	6	811,686,192
Reproductive	7	498,142,705
Kidney	8	488,554,582
Immunological	9	234,713,891
Carcinogenesis	10	209,271,142
Endocrine	11	173,331,065

Reference: Environmental Defense Scorecard (www.scorecard.org)

While the Nation has developed a hazard tracking network, little has been done to link these findings to efforts to track actual population exposure levels or track the health of communities where these releases occur.

EXPOSURE TRACKING

Are communities being exposed to harmful levels of pollutants? Understanding exposure levels is essential in understanding and preventing environmentally-related disease. Ideally, exposure tracking includes the systematic measurement of harmful environmental agents to which individuals are exposed. Exposure tracking also helps evaluate the effectiveness of public health policies. It should be closely coordinated with ongoing hazard tracking.

The National Health and Nutrition Examination Survey (NHANES) illustrates a national approach to exposures. The survey examines a nationally representative sample of about 5,000 Americans each year. Environmental exposure measurements are only one part of NHANES, a broad-based national survey of nutrition and health.

[3] This analysis includes both suspected and recognized toxicants. An agent is listed as a recognized toxicant if it has been studied by national or international authoritative and scientific regulatory agency hazard identification efforts. Suspected agents are included if they are shown to have target organ toxicity in either humans or two mammalian species by a relevant route of exposure.

One of its strengths is that it allows policymakers to evaluate public health intervention policies. For example, NHANES data showed a drop in average blood lead levels between 1976 and 1980, a period that corresponded with the removal of lead from gasoline. These data enabled policymakers and regulators to determine that the ban on leaded gasoline was effective. NHANES has also provided a national profile of exposure to environmental tobacco smoke, thus supporting initiatives to reduce exposures.

Unfortunately, NHANES is not designed to track exposures at the State and local level, and so does little to help public health professionals in responding to a community's local concerns about a possible cluster of health problems related to the environment.

There is potential for progress, however, given advances in sampling and detection for a broad array of human monitoring techniques. But the failure to develop and support a national capacity for exposure tracking and coordinate with ongoing environmental hazard tracking has left a large gap in our approach to environmental protection. The GAO underscored the need to close this gap in a report that called for a national approach to measuring Americans' exposures to pollutants in order to strengthen prevention efforts.

HEALTH OUTCOME TRACKING

Are environmental exposures and population exposures related to increased disease? Understanding trends in the incidence of diseases that may be related to environmental exposures is fundamental to protecting public health. The Commission reviewed a number of national health outcome data bases to examine the availability of information on diseases that may be linked to the environment. Three are particularly worth noting:

- The National Hospital Discharge Survey (NHDS) conducted since 1965 is a continuous survey based on a sampling of patient medical records discharged from hospitals. The survey collects demographic information, admission and discharge dates, diagnoses and procedures performed.
- The National Ambulatory Medical Care Survey (NAMCS) and the National Hospital Ambulatory Medical Care Survey (NHAMCS) are national surveys designed to provide information on the types and uses of outpatient health care services for office-based physicians, emergency rooms and hospital outpatient centers, respectively. This allows us to measure the number of doctor visits pertaining to specific health concerns that may be environmentally-related, such as asthma.
- The National Health Interview Survey (NHIS) is a multistage sample designed to represent the civilian, non-institutionalized population in the United States. The survey is conducted by the CDC's National Center for Health Statistics (NCHS). It has been conducted continuously since 1957. Due to budget reductions, the survey was redesigned in 1997 to track a much more limited set of health problems.

These data bases are not designed to describe either State and local communities or environmentally-related health outcomes, but they provide warning signals or "big picture" level information on the prevalence and trends of health outcomes in need of closer study. For instance, the NHIS data show the 10-year national trend in rising rates of asthma and clearly established it as an epidemic chronic disease. From 1986–1995, the surveys of about 5,000 people annually found that endocrine and metabolic disorders increased by 22 percent, while neurological and respiratory disease increased by 20 percent.

However, the role of the environment in these health outcomes remains unknown. Without an adequate tracking process, such links are difficult to clarify. This type of snapshot data does not provide the full panoramic view needed by health professionals to identify clusters, uncover risks or guide the prevention programs that make people healthier.

A LOOK AT STATE AND LOCAL CAPACITY FOR TRACKING

The Commission interviewed environmental health leaders from public health agencies in the 50 States and a sample of local health departments as part of its examination of State and local public health capacity for environmental health tracking. While some States and localities have well-developed programs, others have virtually no capacity for environmental health tracking. Overall, the survey found that the State and local infrastructure for environmental health tracking has been neglected; with the result that today many have outmoded equipment and information systems, and lack technical and laboratory support. As a result, fundamental information about community health status and environmental exposures is not available.

In a Commission survey of State health officials, it was found that while over three quarters of State health departments track blood lead levels, biomonitoring for other substances, including hazardous pesticides, is very limited. Only about 25 percent said their departments can measure human exposure to environmental contaminants by monitoring the air in a person's breathing zone, an important investigative capability in responding to a health threat. Most of the chronic diseases and health problems that the Commission identified as priorities are not being tracked.

Even for health problems that most States do track—cancer, infectious disease and birth defects—tracking efforts have significant problems. For instance, an earlier Pew Commission report found that while 33 States have birth defect registries, the majority was inadequate in terms of generally recognized standards for an effective tracking program. Another Commission study found similar gaps in State efforts.

Finally, information that is tracked according to current standards is often not usable for intervention, policy, and scientific purposes. First, State data sets commonly lack enough samples from more refined geographic areas to make it possible to characterize health hazards, exposures and outcomes at the local level. In addition, the Commission's survey found that many departments lack the staffing, expertise, or technology to analyze and in some cases even to access existing data sets relevant to local environmental health. Rather, local health practitioners find themselves focusing on enforcement and reacting to complaints. Another concern is the absence of national standards to ensure consistent data collection.

State and local public health agencies are the foundation of the nation's health tracking capacity. The first requirement for an effective, integrated network is strong State and territorial public health organizations with linkages to strong local health agencies, as well as Federal agencies, healthcare providers, State environmental agencies and communities. While the States and localities may have the will, this vision of a Nationwide Health Tracking Network will only come together with the support, guidance and leadership of the Federal Government.

THE TIME IS RIGHT

Advances in hazard identification, exposure assessment health outcome data collection and information technology provide unprecedented opportunities for advancing tracking and improving our understanding of the environment and health.

Despite the challenges, there are unprecedented opportunities to strengthen the national infrastructure for environmental health information, expand public access to this important information and protect the privacy of individuals. New technologies in biomonitoring have the potential to transform the nation's capacity to track exposures to pollutants and understand their impacts on health. Advances in communication and information technology have expanded opportunities for public access and given us new tools to analyze, map and disseminate health data. New technology also can improve safeguards to protect the confidentiality of identifiable personal health information. We have better tools than ever before to meet the public health missions of protecting Americans' health and privacy.

New initiatives at CDC and EPA have the potential to address tracking needs, including information technology development and State and local capacity-building, along with exposure measurement, interagency coordination and public access to health information. Opportunities exist, but we need to do more to advance the science and support for inclusion of environmental health components.

The integration of public health information and tracking systems is listed as a top priority of the CDC. Spurred by concerns about bioterrorism, a Health Alert Network is being developed to improve tracking and information sharing on key infectious diseases and priority chemical and poison agents that may be used in terrorist attacks. In addition, there are several other data systems being developed by CDC and EPA that could be building blocks in a national tracking network. However, national vision and leadership to bring this all together on behalf of environmental health issues will be required if any of these current initiatives are to become building blocks for a national environmental health tracking network.

Environmental health tracking will give us an unprecedented opportunity to ensure our environmental policies are successfully reducing exposures in our communities and safeguarding public health.

Reduction of risks from hazards in the environment and people's exposures and the improvement of public health are fundamental goals of environmental regulations. At present, tracking activities are focused primarily on hazard identification for regulatory permitting and enforcement. Improved capacity to measure peoples' exposures to hazards and track health outcomes will strengthen the scientific basis for these important policy decisions. In addition, environmental health tracking will

give practitioners and policymakers better indicators of progress, and assure that benefits of healthier communities continue well into the future.

The public increasingly wants and demands more credible environmental health information so that they can make independent and fully informed decisions. The Internet explosion has further fueled this desire.

Recent public opinion research confirms that Americans want to have access to national, State and community level health data. In fact, they are incredulous when informed that health tracking information is not readily available. The Internet now allows the public quick and highly accessible information on most facets of their lives. There is a widespread belief that health tracking information should be and needs to be available to the public. With growing concerns about environment and health, this public demand should help support the Network.

Recently, a group of environmental health leaders held a summit co-sponsored by the Pew Environmental Health Commission, the Association of State and Territorial Health Officials, the National Association of County and City Health Officials, and the Public Health Foundation at which they strongly endorsed the Commission's efforts to strengthen environmental health tracking.

Summit participants endorsed a tiered approach to national environmental health tracking that is consistent with the Commission's five-tier recommendation. It includes: national tracking for high-priority outcomes and exposures; a sentinel network to identify acute and emerging hazards; a coordinated network of pilot regional, State and local tracking programs; and aggressive research efforts to guide and evaluate tracking.

WHY WE NEED A HEALTH TRACKING NETWORK NOW

Earlier this year, a scientific breakthrough was announced that has incredible potential to help us understand the links between people, their environment and behaviors, genetic inheritance and health.

As researchers begin to apply this new genetic knowledge to the study of disease, we will have more information than ever before to use in revealing the connections between environmental exposures, people's behaviors and genetic predisposition to health problems. But only if we have the basic information about what is going on in our communities—the hazards, the exposures and health problems that Americans are experiencing.

The "building blocks" of knowledge provided by the Nationwide Health Tracking Network will enable scientists to answer many of the troubling questions we are asking today about what is making us sick. The Network will provide the basis for communities, health officials, businesses and policymakers to take action for making this Nation healthier. The result will be new prevention strategies aimed at reducing and preventing many of the chronic diseases and disabling conditions that afflict millions of Americans.

The Commission is calling upon our national leaders to take the steps outlined in this report, and with a minimal investment, revitalize our nation's public health defenses to meet the challenges of this new century. It is time to close America's environmental health gap.

THE PEW COMMISSION PRINCIPLES FOR PROTECTING PRIVACY AND CONFIDENTIALITY AND OUR ENVIRONMENTAL HEALTH RIGHT-TO-KNOW

Without a dynamic information collection and analysis network, public health agencies would be ineffective in protecting health. The Commission recognizes the substantial benefits that accrue from personally identifiable health information and provides these principles to assist agencies in addressing privacy and confidentiality concerns associated with collection and use of this information in environmental health investigations.

The Commission is aware of the sensitivity of individually identifiable health information and is committed to protecting the privacy of such information and to preventing genetic and other sensitive health information from being used to discriminate against individuals. The Commission believes that the values of public health activities and privacy must be reasonably balanced.

The Commission also is aware of the need to increase public confidence in our nation's public health system by making nonidentifiable health information and trends widely available and providing access to the analyses of collected data. This also will serve to better inform communities about the value of public health data.

The Commission believes that adherence to the following principles will enable public health agencies to honor their traditional commitment to the confidentiality

of individually identifiable health records without significantly hampering execution of their obligations to the public health:

• Recognize that it is largely possible to balance the protection of individually identifiable health information and the acquisition, storage and use of that information for environmental health purposes;

• Protect individuals' privacy by ensuring the confidentiality of identifiable health information;

• Disclose only as much information as is necessary for the purpose in cases where the public health requires disclosure of identifiable information;

• Require that entities to which identifiable information has been disclosed take the same measures to ensure confidentiality that are taken by the disclosing agency;

• Utilize the best available organizational and technological means to preserve confidentiality of information (includes such measures as limiting access, staff training, agreements and penalties as well as updating of security measures);

• Provide individuals the opportunity to review, copy and request correction of identifiable health information.

SHEPHERD MILLER
INCORPORATED

April 8, 2001

SMI #100623

Mr. Mike Mackedon
Fallon City Attorney
Mackedon, McCormich, and King
179 South LaVern Street
Fallon, NV 89406

Dear Mr. Mackedon:

Enclosed is a preliminary cost estimate for the City of Fallon to build a water treatment plant. Also included are the costs for the Navy to build their own plant, and the costs to build a combined plant. We estimate that a capital cost savings of between approximately $800,000 and $1,000,000 will be realized by building a combined plant instead of separate treatment plants. In addition, operations and maintenance (O&M) costs for a combined plant will be less than the sum of the costs for separate plants. Much of the savings for the O&M costs would come from using the mixed-media filter system currently proposed for the City instead of the microfiltration system undergoing testing by the Naval Air Station.

We would like to again emphasize that the costs we have provided are preliminary estimates and will most likely change. As you know, we are still performing pilot-scale testing and have not finalized the coagulant and acid types, or required concentrations, necessary for treatment. While we believe that the attached costs are a good initial estimate, the final design costs may vary, possibly significantly, depending on a number of factors. For example, the estimated building costs will likely vary between the Wastewater Plant Site and the Cemetery Site due to the high groundwater table at the Wastewater Plant Site. Another example would be the quality of the components used in the treatment plant. Higher quality components may cost more initially but should lead to lower maintenance and operation costs over the life of the plant. The final arsenic MCL will also have a direct affect on the design and operational costs.

If you have any questions, please free to call me at (970) 223-9600.

Sincerely,
SHEPHERD MILLER, INC.

Tim R. Runnells
Hydrogeologist, Project Manager

Enclosure

Environmental & Engineering Consultants

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ESTIMATED COSTS FOR CONSTRUCTION, DESIGN, AND OPERATION OF INDIVIDUAL TREATMENT PLANTS AND A COMBINED TREATMENT PLANT FOR THE CITY OF FALLON AND NAVAL AIR STATION-FALLON

CONSTRUCTION AND DESIGN CAPITAL COSTS	CITY OF FALLON[1,2,3] ($000)	NAVAL AIR STATION[4] ($000)	TOTAL COST-SEPARATE PLANTS[5] ($000)	COSTS-COMBINED PLANT[5] ($000)	COST SAVINGS- COMBINED PLANT VS. SEPARATE PLANTS[5] ($000)
Estimated Treatment Facility Cost	7,300	3,470	10,770	9,386	1,384
Contingency @ 15% (City & Combined) & 5% (Navy)	1,095	174	1,269	1,408	(139)
Subtotal	$8,395	$3,644	$12,039	$10,794	$1,245
Contractor's Overhead and Profit	1,095	208	1,303	1,408	(105)
Subtotal	$9,490	$3,852	$13,342	$12,201	$1,140
Engineering Design & Construction Phase Services @ 15%	1,424	578	2,001	1,830	171
Total Construction and Design Costs	$10,914	$4,429	$15,343	$14,032	$1,311

UTILITY AND ROAD CAPITAL COSTS	CITY ONLY-CEMETERY SITE ($000)	CITY ONLY-WATER TANK SITE ($000)	CITY ONLY-WASTEWATER SITE ($000)	COMBINED-CEMETERY SITE ($000)	COMBINED-WATER TANK SITE ($000)	COMBINED-WASTEWATER SITE ($000)
Transmission Pipeline Costs[6,11]	1,394	1,548	1,705	1,695	1,877	2,218
Partial Upgrade of City High Pressure Line[6,7]	656	656	656	656	656	656
Booster Pumps	UNK	UNK	UNK	UNK	UNK	UNK
Power[8]	75	100	10	75	100	10
Access Road[9]	10	140	10	10	140	10
Sewer[10]	65	195	10	65	195	10
Total Utility and Road Costs	$2,200	$2,639	$2,391	$2,500	$2,968	$2,904

SUMMARY OF CAPITAL COSTS	SEPARATE PLANTS-CEMETERY SITE ($000)	SEPARATE PLANTS-WATER TANK SITE ($000)	SEPARATE PLANTS-WASTEWATER SITE ($000)	COMBINED-CEMETERY SITE ($000)	COMBINED-WATER TANK SITE ($000)	COMBINED-WASTEWATER SITE ($000)
City of Fallon - Construction and Design	$10,914	$10,914	$10,914	$10,914	$10,914	$10,914
City of Fallon - Utility and Road	$2,200	$2,639	$2,391	$2,200	$2,639	$2,391
Navy - Construction and Design	$4,429	$4,429	$4,429	$3,118	$3,118	$3,118
Navy - Utility and Road	$0	$0	$0	$301	$329	$513
TOTAL CAPITAL COSTS	$17,543	$17,982	$17,734	$16,532	$16,999	$16,936
SAVINGS - COMBINED PLANT				$1,011	$982	$798

OPERATIONS AND MAINTENANCE	CITY OF FALLON ($000)		NAVAL AIR STATION[14] ($000)		COMBINED ($000)	
	Year 1	Year 20	Year 1	Year 20	Year 1	Year 20
Estimated Annual Operation and Maintenance Costs[12]	250 - 500	500 - 750	165	165	350 - 600	600 - 850
Estimated Annual Savings - Combined Plant (Water Tank or Cemetery Site)					$50-$75	$50-$75
Estimated Annual Savings - Combined Plant (Wastewater Site)[13]					$75-$100	$75-$100

1 = Costs are based on a conceptual design and will vary depending on final design. Assumptions include: (1) 3% City growth per year from 2000 through 2020, (2) average per capita usage of 240 gallons per day, (3) peak daily demand will increase at a rate similar to growth, and (4) peak demand in 2020 of 7 million gallons per day. Water usage, population, and growth values used in these costs were provided by the City of Fallon.
2 = Costs for construction at all three sites are assumed to be similar. Additional construction costs to address unusual (i.e., high water table, heaving soils, liquefaction, etc.) geotechnical considerations are not included.
3 = Costs do not include backup power supply and redundancy of treatment plant systems.
4 = Costs provided by the Naval Air Station and assume a peak demand of 2 million gallons per day. Costs include electrical, sewer, booster pumps, and hookup to Naval transmission line.
5 = Footnotes 1, 2, 3, and 4 apply to this cost.
6 = Transmission pipeline costs are based on actual bid costs for the City's 1995 transmission pipeline project and have been adjusted for inflation using the average annual change in the Engineering News Record Construction Cost Index for years 1995-2001. These costs may vary depending on region and construction activity at the time of work. Costs for blasting (if necessary) are not included. Costs are for installation of 12-inch pipe, the incremental cost for 15-inch pipe, which will be required, have not been included.
7 = Will likely be required due to changes in pressure, velocity, and water chemistry. Pipeline distance provided by City of Fallon.
8 = Unit costs provided by the City of Fallon.
9 = Road base (6 inches) and asphalt (3 inches) based on an actual quote from a local contractor. Subgrade preparation based on 25% of quote.
10 = Sewer costs provided by the City of Fallon. Costs for blasting (if necessary) are not included.
11 = Pipeline distances provided by the Naval Air Station.
12 = Costs will vary and may increase based on the plant design and final arsenic standard.
13 = Labor, fuel, and vehicle maintenance savings due to proximity of wastewater plant.
14 = Costs provided by Naval Air Station.

SHEPHERD MILLER, INC.
Environmental and Engineering Consultants

TECHNICAL MEMORANDUM

DATE: April 6, 2001 **SMI #** 100771

TO: Mr. Mike Mackedon – City of Fallon Attorney

FROM: Shepherd Miller, Inc.

SUBJECT: Results of Additional Groundwater Analyses

1.0 INTRODUCTION

At the request of the City of Fallon (City), Shepherd Miller, Inc. (SMI) has performed additional testing and analyses of the City's groundwater supply. The purpose of these additional analyses is to determine the presence/absence of selected analytes that had not been previously tested for in the City's groundwater supply. The analytes were selected based on the following criteria: (1) potential leukemia-causing chemicals or analytes that had not been analyzed for previously, (2) radionuclides that may be present from the Shoal underground nuclear test in 1963, and (3) selected analytes based on comments and concerns by citizens of the City. This memorandum summarizes the collection and results of the additional testing. A report to be submitted in the near future will present all information related to the additional sampling, analyses, and results.

2.0 IDENTIFICATION AND SAMPLING OF ADDITIONAL ANALYTES

From mid-December 2000 to late January 2001, SMI performed a literature review for potential leukemia causing chemicals or analytes. Based on this review, a list of chemicals and analytes was developed that had not previously been tested for in the City drinking water supply. On February 7, 2001, the City wells were sampled for analytes or chemicals that had not been tested for previously, and could be potentially leukemia causing. A few analytes or chemicals were not included in the analyses because they are: (1) a pharmaceutical use and highly unlikely to be found in City groundwater, (2) currently have no standard analytical method for analysis, (3) only found if used as part of a water treatment system, or (4) highly reactive and not expected to persist in groundwater. The resulting analytes or chemicals that were tested for in February 2001, included formaldehyde, lead-210, and radium-224.

Due to questions and concerns by the City residents about the proximity of the Shoal underground nuclear test and specific concerns by citizens about one chemical (perchlorate), additional samples were collected from the City wells on March 8, 2001. The analytes tested for included plutonium, tritium, and perchlorate.

The procedures and methods followed during sampling reflect general methods and protocols that are typically employed in the industry and are accepted by the United States Environmental Protection

Agency (EPA). Procedures followed included: (1) decontamination of sampling equipment, (2) purging of wells, (3) sample collection, (4) sample labeling, preservation, and shipping, and (5) sample custody procedures. All samples collected during these sampling events were performed either under the supervision of SMI or by SMI employees.

3.0 RESULTS OF SAMPLE ANALYSIS

Table 1 presents the results of the analyses for samples collected from the City of Fallon wells in February and March, 2001. The results indicate that most of the analytes are not present at the reporting limit or minimum detectable concentration. The concentrations of the two analytes that were detected, gross alpha and lead-210, are well below the regulatory limit and concentrations that would be of concern for human health. Stringent data validation of the results indicate that the reported results are accurate and acceptable for use.

TABLE 1. Reported Values of Analyses Performed in February and March, 2001

ANALYTE	WELL 1	WELL 2	WELL 3	WELL 4
Formaldehyde (µg/L)	<50	<50	<50	<50
Gross Alpha (inc. Ra-224) (pCi/L)	7	7	6	3
Lead-210 (pCi/L)	0.6	0.5	-0.1	1.6
Perchlorate (µg/L)	<4	<4	<4	<4
Plutonium-238 (pCi/L)	<0.03	<0.026	<0.013	<0.033
Plutonium-239 (pCi/L)	<0.012	<0.040	<0.013	<0.014
Tritium (pCi/L)	<340	<340	<340	<340

SHEPHERD MILLER, INC.
Environmental and Engineering Consultants

TECHNICAL MEMORANDUM

DATE: April 8, 2001 **SMI #** 100623

TO: Mr. Mike Mackedon – City of Fallon Attorney

FROM: Shepherd Miller, Inc.

SUBJECT: Summary of Arsenic Treatment Work

In April 2000, the City of Fallon engaged Shepherd Miller Incorporated (SMI) as an engineering and environmental consultant. At that time, SMI prepared a preliminary scope of work for reducing arsenic concentrations in the City of Fallon groundwater supply. The following sections provide a brief description and timeline of the work performed to date.

1.0 GROUNDWATER CHARACTERIZATION

In May 2000, SMI performed sampling and comprehensive inorganic analysis of the City of Fallon's groundwater supply. Three independent laboratories were used to perform the analyses of the groundwater in order to provide assurance that results were accurate. All data were validated using Environmental Protection Agency National Functional Guidelines for Inorganic Data Review. A report on the results of this analysis was presented to the City of Fallon on September 15, 2000.

2.0 EVALUATION OF TECHNOLOGIES TO REDUCE ARSENIC CONCENTRATIONS

In mid-July, SMI performed a literature review and evaluation of technologies to reduce arsenic concentrations in the City of Fallon groundwater supply. At the time of the evaluation, the final arsenic maximum contaminant level (MCL) had not been set; therefore, the evaluation was focused on identifying a technology or technologies that could be used to reduce arsenic concentrations to meet both the existing and proposed arsenic MCLs of 50 and 5 micrograms/liter, respectively. SMI completed this evaluation and submitted a report of the results to the City of Fallon on September 1, 2000.

3.0 BENCH-SCALE TESTING OF TECHNOLOGIES

On September 18, 2000, SMI commenced bench-scale (laboratory) testing of the two most promising technologies identified during the technology review and evaluation. The technologies evaluated at the bench-scale level consisted of enhanced coagulation with ferric iron and strong-base anion exchange. SMI completed this evaluation in mid-November, 2000. The results of the bench-scale testing indicated that the enhanced coagulation with ferric iron was the preferred alternative for the following reasons: (1) effectiveness, (2) reliability, (3) flexibility to meet both the existing and proposed (at that time) MCL, (4) waste products (both solid and liquid), (5) capital costs, (6) consumptive water use, and (7) operating costs. The results of this work were submitted to the City of Fallon on February 6, 2001.

4.0 PILOT-SCALE TESTING

On November 20, 2000, SMI contracted with Hydrokinetics Systems of Salem, Oregon, to provide pilot-scale testing using the preferred arsenic treatment alternative (i.e., enhanced coagulation with ferric iron). Pilot-scale testing commenced on November 30, 2000, at Well #3 in the City of Fallon. Initial pilot-testing occurred from November 30, 2000 through March 16, 2001. The initial pilot testing was manually operated at flow rates of 1 to 2 gallons per minute using various coagulants and pH adjusters including: (1) ferric chloride, (2) ferric sulfate, (3) aluminum sulfate, (4) sulfuric acid, and (5) hydrochloric acid. In addition, a number of different types of filters were tested, including: (1) a mixed media filter (garnet, silica sand, and anthracite), (2) contact clarifier (anthracite) with a monofilter (poly-coated glass spheres), (3) ceramic microfilter, and (4) polymeric microfilter. Results from the initial pilot testing indicated that arsenic concentrations can be reduced below 5 micrograms/liter using pH adjustment, a ferric coagulant, and media filtration (either mixed or mono).

During the week of March 18, 2001, a larger, automated, pilot-scale system was constructed in order to validate the results obtained during the initial pilot testing. In addition, the larger pilot system will provide operational parameters necessary for design of a full-scale plant. Testing using the larger pilot system began on March 27, 2001, and is on-going. The first set of laboratory analyses from the large pilot system is expected the week of April 8, 2001. Barring unforeseen circumstances, the pilot-scale testing is anticipated to end on or before May 31, 2001.

A by-product of the coagulation and filtration treatment process is a iron/arsenic sludge. As part of the pilot-scale work the sludge has been to tested to determine disposal options. Preliminary results indicate that the sludge will be stable (i.e., will not leach arsenic in excess of regulatory standards) and can be disposed in the City of Fallon landfill. This testing is ongoing and a second set of test results is expected the week of April 15, 2001.

5.0 SITING OF THE TREATMENT PLANT

Determination of the optimum treatment plant location began the week of March 11, 2001. In order to comply with the National Environmental Policy Act (NEPA), an environmental assessment (EA) is being prepared as part of treatment plant siting. Major sections of the EA include an alternatives analysis, determination if threatened or endangered species are present at the sites, and determination if the sites contain significant historic or cultural items. An alternatives analysis of the possible locations is approximately 75 percent complete and has an anticipated mid-May completion date. The alternatives analysis includes comparison costs for electrical, access, sewer, required piping, and booster pumping. In addition, the socio-political concerns are addressed as part of the alternatives analysis. The site cultural and threatened and endangered surveys have been completed and completion of the final reports of the results are anticipated in late-May.

P: 100771

SHEPHERD MILLER, INC.
Environmental and Engineering Consultants

MEMORANDUM

DATE: April 9, 2001 **SMI #** 100771

TO: Mr. Mike Mackedon

FROM: Shepherd Miller Inc.

SUBJECT: Technical Consultation

The City of Fallon engaged Shepherd Miller, Incorporated, Environmental and Engineering Consultants of Fort Collins, Colorado, to provide technical consultation and assistance to the City of Fallon as of April 2000.

1.0. The initial scope of work as agreed upon by Shepherd Miller and the City of Fallon included the following:

a. Conduct a survey of available data relating to hydrogeology of the Lahontan Valley Basin with specific emphasis on the Basalt aquifer.

b. Review historic laboratory analyses of the drinking water supply for the City of Fallon's water utility.

c. Implement, supervise and perform quality assurance and quality control protocols for comprehensive analysis of inorganic water chemistry of the City of Fallon water supply.

d. Conduct a survey of available and/or innovative technologies which can remove arsenic from drinking water.

e. Select from available technologies those particular technologies suited to the water chemistry of the City's drinking water supply for the purpose of performing treatment technology testing.

f. Perform bench-scale tests of selected treatment technologies.

g. Review, analyze, and evaluate bench-scale test results.

h. Perform pilot-scale testing on selected treatment technology indicated by bench-scale test results[1].

i. Evaluate pilot-scale testing results.

j. Recommend a final arsenic treatment technology to the City.

[1] Bench-scale test results have been concluded and a recommendation for treatment of arsenic in the water supply of the City of Fallon has been finalized; pilot-scale testing which commenced on November 30, 2000 at City Well #3 is ongoing.

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k. Consult and advise the City regarding siting, design and operation of arsenic treatment system for the City of Fallon with a goal toward removing arsenic from the drinking water supply to a level not greater than 5 parts per billion.

l. Assist and advise in identifying, reviewing, and applying to funding sources and monitoring regulatory compliance issues and processes.

2.0. Shepherd Miller's scope of work was expanded in July of 2000 when the City of Fallon learned that a number of cases of childhood leukemia had been diagnosed in residents of Churchill County which might indicate or suggest an environmental cause. The new scope includes the following additional work assignments:

a. Ongoing review of the available literature and research to confirm or not confirm a connection (primary or secondary) between the ingestion of arsenic and childhood leukemia.

b. Ongoing review of the available literature and research, to confirm or not confirm a connection between the intake of radon and childhood leukemia.[2]

c. Review the record of historical analyses of the water chemistry of the City of Fallon drinking water supply with a view toward retesting or conducting new tests of a more extensive nature - as indicated by the review.

d. Develop a list of agents known or suspected to cause leukemia and perform tests for agents not previously analyzed to determine the presence or absence of same in the drinking water supply of the City of Fallon.[3,4]

e. Perform additional testing and analysis beyond previous testing, as requested by the City of Fallon. This additional testing includes radiological, inorganic, and volatile organic analyses.

f. Provide ongoing consultation to the Mayor and City Council members of the City of Fallon so that the City of Fallon might assist in providing technical information or make scientific contributions to the Nevada Health Department of other agencies studying the cases of childhood leukemia.

g. Provide technical assistance to the City of Fallon and prepare reports to and otherwise respond to any other official inquiry regarding the childhood leukemia cases or other public health issues relating to the activities and enterprises of the City of Fallon, especially its water utility.

[2] Radon is not present in the City drinking water supply at concentrations greater than the recommended level (RL).

[3] Shepherd Miller, in response to the mandate of its expanded scope of work, has retained Glyn Caldwell, M.D., Director, Division of Epidemiology and Health Planning, Department of Public Health, City of Frankfurt, Kentucky, as an outside expert in the study of leukemia.

[4] Results to date indicate that the City of Fallon water supply contains no naturally occurring or introduced element, chemical, compound, component of a compound, radionuclide or other detectable and analyzable carcinogenic substance (initiator, promoter or contributor) which exceeds any maximum contaminate level (MCL) set either by USEPA or Nevada EPA except Arsenic 5; No research has been found showing a clear link between ingestion of arsenic and childhood leukemia; and, in view of the water chemistry analyses of the drinking water supply of the City of Fallon and the "Nevada study" data available to the City of Fallon defining the local childhood leukemia cases, it appears unlikely that the drinking water supply for the City of Fallon is linked to these cases whether by reason of its arsenic level of 100 parts per billion or any other substance.

h. The expanded scope of work was, and is, intended to provide new information and a comprehensive review of the historic water chemistry record of analyses which have been performed by the City of Fallon water utility as required by law or regulation. Historically the water chemistry analyses performed by the City of Fallon water utility have been in excess of that required by law or regulation. In addition, the City of Fallon water utility is testing for any other agent known or suspected to cause leukemia, which had not been previously analyzed, whether or not mandated by any law or regulation.[5]

[5] Results to date indicate that the City of Fallon water supply contains no naturally occurring or introduced element, chemical, compound, component of a compound, radionuclide or other detectable and analyzable carcinogenic substance (initiator, promoter or contributor) which exceeds any maximum contaminate level (MCL) set either by USEPA or Nevada EPA except Arsenic 5; No research has been found showing a clear link between ingestion of arsenic and childhood leukemia; and, in view of the water chemistry analyses of the drinking water supply of the City of Fallon and the "Nevada study" data available to the City of Fallon defining the local childhood leukemia cases, it appears unlikely that the drinking water supply for the City of Fallon is linked to these cases whether by reason of its arsenic level of 100 parts per billion or any other substance.

Draft

PRELIMINARY EVALUATION OF TREATMENT TECHNOLOGIES FOR ARSENIC IN THE GROUNDWATER SUPPLY OF THE CITY OF FALLON, NEVADA

Prepared for:
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September 1, 2000

SHEPHERD MILLER
INCORPORATED

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1.0 INTRODUCTION

This report presents the preliminary evaluation of treatment technologies for reduction of soluble arsenic concentrations in the City of Fallon drinking water supply. Recent sampling of the deep aquifer (SMI, 2000) from which the city obtains its potable supply confirms that this source contains a mean concentration of 0.105 milligrams per liter (mg/L) dissolved arsenic. Because Fallon does not currently employ treatment of its supply (other than disinfection), and because the new EPA drinking water regulation for arsenic is proposed to be 0.005 mg/L, the city is investigating possible treatment solutions for this contaminant.

The product of this preliminary evaluation is the recommendation of those technologies that appear to be most suited for the City of Fallon. The goal is to identify an effective treatment technology that is both easy to implement and operate, while entailing reasonable costs to install and operate. The alternatives that have been evaluated in this study are known to be effective for removal of aqueous arsenic. In addition to treatment effectiveness, the evaluation also utilizes criteria that cover relative factors such as process water consumption, treatment residuals, ease of operation, and costs. The criteria were evaluated based on: (1) validated groundwater quality data collected in May 2000, (2) published information on treatment technologies applicable to this water quality, and (3) experience with, and professional knowledge of, arsenic-specific water treatment.

In addition to treatment technologies, this report also reviews potential alternatives to the existing water supply, as well as methods to reduce the potable water consumption rate.

2.0 AQUEOUS ARSENIC CHEMISTRY

In natural aqueous environments, the occurrence of arsenic (As) is in its inorganic form, with little significant presence of the organic forms that are usually related to application of agricultural chemicals. Arsenic is present in nature in four stable oxidation states (5+, 3+, 0, 3-), but only the pentavalent (5+) and trivalent (3+) inorganic forms of arsenic are important in aqueous solutions. In oxygenated water, pentavalent arsenic (As^{5+}) is the dominant species, whereas trivalent arsenic (As^{3+}) is most stable under anoxic conditions.

When dissolved in solution, arsenic will react with water molecules (hydrolysis) to form various protonated species (weak acids). In neutral solutions (pH 7), the predominant species of arsenic are $HAsO_4^{2-}$ for arsenate and $H_3AsO_3^{o}$ for arsenite. The other equilibrium species of arsenic that are significantly present will be dictated by solution pH. In general, the number of protons associated with the arsenic molecule decrease as pH values increase, and the overall charge of the compound becomes more negative. Distribution diagrams for aqueous arsenic species can be found in most standard textbooks that discuss arsenic chemistry.

In the pH range typically observed in natural waters and in treatment units (pH 4 to 10), the arsenic species of importance are reduced to only a few. For arsenate, these are the anions $H_2AsO_4^-$ and $HAsO_4^{2-}$, with the lower charged species ($H_2AsO_4^-$) dominant below pH 6.8. Likewise for arsenite, the neutral species ($H_3AsO_3^{o}$) is dominant to pH 9.2, whereas $H_2AsO_3^-$ becomes more important above this pH. The relevance of the different arsenic species to water treatment technologies will become apparent in the discussion of specific treatment processes.

3.0 GROUNDWATER QUALITY IN FALLON CITY WELLS

Based on the analytical results for groundwater samples collected in May 2000 (SMI, 2000), the City of Fallon drinking water supply is characterized as a sodium/bicarbonate water. The groundwater samples collected from the basalt aquifer contained few analytes at concentrations above the laboratories' detection limits. Only the major cations and anions (calcium, magnesium, sodium, potassium, sulfate, chloride, nitrate, bicarbonate, and carbonate), arsenic, fluoride, and silica, were consistently detected by all laboratories. A summary of water quality in the four city wells is provided in Table 1. Water quality results from two Naval Air Station (NAS) wells, which are completed in the same aquifer as the city wells, are also provided for comparison.

As shown in Table 1, the concentrations of several important constituents in this water source are notable. Arsenic speciations performed by both the field sampling team and by the analytical laboratories indicate As^{5+} is the only arsenic species detectable in the groundwater. From the analytical laboratory measurements, it can be seen that As^{5+} is present in the City and NAS well water at a concentration slightly above 0.1 mg/L, and that As^{3+} was not detected. Because most treatment technologies applicable to arsenic have been demonstrated to be more effective for removing As^{5+}, and because As^{5+} appears to be the only detectable arsenic species in the Fallon groundwater, this evaluation does not consider treatment steps for oxidation of As^{3+}.

Other constituents that are important when evaluating treatment technologies for arsenic are sulfate, chloride, and silica. Although not present at unusually high concentrations, the molar concentration ratio of these anions to arsenic in the Fallon water supply is substantial, 650 for sulfate, 1,860 for chloride, and 320 for silica. Phosphate, nitrate, and bicarbonate are also important to this evaluation, but to a lesser degree because they are present at lower relative concentrations or because their influence on treatment is secondary. When evaluating technologies sensitive to these constituents, their potential effects to the overall feasibility of arsenic removal are addressed.

Table 1 City of Fallon Groundwater Quality

	CITY WELLS			NAS WELLS	
	Mean[1]		Std. Deviation	Mean	Std. Deviation
	mg/L	mmole/L	mg/L	mg/L	mg/L
FIELD					
pH (field)	9.16		0.02	9.15	0.06
Conductivity (µS/cm)	937		37	1089	3
Temp (°C)	20.0		0.4	21.8	1.3
Turbidity (ntu)	0.3		0.16	0.2	0.08
LABORATORY					
Total Alkalinity	215	2.1	9	232	12
Bicarbonate	176	1.8	18	181	3
Carbonate	43	0.4	12	50	10
Hydroxide Alkalinity	<1	--	--	<1	--
Turbidity (ntu)	<1	--	--	<1	--
TDS	533	--	17	597	17
Nitrate as N	0.38	0.03	0.03	0.50	0.005
Nitrite as N	<0.25	--	--	<0.25	--
Calcium	1.4	0.04	0.1	1.1	0.1
Magnesium	0.5	0.02	0.1	0.5	0.1
Potassium	8.4	0.22	2.0	8.9	2.6
Sodium	205	8.9	18	234	28
Chloride	92	2.6	7	110	6
Fluoride	0.6	0.03	0.1	0.7	0.1
Silica	28	0.45	5	27	4
Sulfate	87	0.91	4	96	4
Aluminum	<0.02	--	--	<0.02	--
Antimony	<0.002	--	--	<0.002	--
Arsenic (+3F)[2]	<0.002	--	--	<0.002	--
Arsenic (+5F)[2]	0.102	0.0014	0.007	0.109	0.009
Barium	<0.002	--	--	<0.002	--
Beryllium	<0.002	--	--	<0.002	--
Cadmium	<0.002	--	--	<0.002	--
Chromium	<0.005	--	--	<0.005	--
Chromium	<0.005	--	--	<0.005	--
Silver	<0.006	--	--	<0.006	--
Copper	<0.01	--	--	<0.01	--
Iron	<0.02	--	--	<0.02	--
Lead	<0.002	--	--	<0.002	--
Manganese	<0.002	--	--	<0.002	--
Mercury	<0.0005	--	--	<0.0005	--
Nickel	<0.02	--	--	<0.02	--
Selenium	<0.002	--	--	<0.002	--
Thallium	<0.001	--	--	<0.001	--
Zinc	<0.02	--	--	<0.02	--
Arsenic (+3L)[3]	<0.002	--	--	<0.002	--
Arsenic (+5L)[3]	0.107	0.0014	0.009	0.116	0.016
Phosphorus as P[4]	0.223	0.007	0.005	0.235	0.007

Less than values (<) represent the middle detection limit for multiple laboratory reporting limits.

1. Mean values for analytical results from three laboratories and four city wells.
2. Indicates arsenic speciation procedure conducted in field.
3. Indicates arsenic speciation procedure conducted by analytical laboratories.
4. Values represent measurements from only one analytical laboratory.

4.0 EVALUATION CRITERIA

For this study, the potential of each treatment alternative for application to the city's drinking water supply is evaluated using screening-level criteria. This screening-level assessment serves as the decision tool for identifying candidate technologies to be investigated further in a Phase 2 study. The criteria that are evaluated for each of the alternatives listed in Section 5 are shown in Table 2 below. Although the list of criteria applicable to evaluating treatment technologies can be more extensive than that shown in Table 2, these eight criteria are suitable for a preliminary assessment. For the purposes of this report, we have also assumed that these eight criteria are weighted equally relative to each other.

Table 2 Phase 1 Evaluation Criteria

Criterion	Description
1. Effectiveness	Ability to consistently meet a treated arsenic standard of 5 μg/L?
2. Treated Water Quality	How will the alternative affect the overall product water quality?
3. Water Loss/Recovery	How much water is wasted in the process?
4. Raw Water Composition	Is process effectiveness significantly affected by raw water quality?
5. Residuals Management	Potential impact of handling and disposal of treatment residuals.
6. Ease of Operation	Ease of process control, automation, and operation.
7. Initial Cost	Initial estimated capital costs.
8. Annual Cost	Estimated operational, maintenance, and improvement costs.

For most of the alternatives, a rating is given to describe and compare each criterion. A scale of 1 to 4 is used, with "1" indicating low feasibility or high cost and "4" indicating high feasibility or low cost. A "4" was the highest relative rating among the alternatives rated. The rationale for each score is also presented for each alternative. If an alternative was relatively ineffective for As^{5+} removal, had only limited performance data available, or was simply impractical for the current situation, the alternative was not further evaluated using the criteria presented in Table 2.

Relative cost ratings are based on capital investments, operation, and maintenance of facilities predicted to be required for an average projected 2020 demand. Because of the high degree of uncertainty inherent in this level of evaluation, dollar value costs for each alternative are not estimated. A more meaningful and sufficient method is to qualify (rate) the estimated costs relative to each alternative that is compared. Cost criteria are evaluated such that lower relative costs receive a higher rating (i.e., a "4" indicates the lowest relative cost factor).

The current groundwater quality indicates that TDS concentrations and pH are outside EPA's non-enforceable, secondary drinking water criteria. Although these constituents are not a priority in this evaluation, those alternatives that meet the TDS and pH secondary criteria, while achieving high water recovery, received special consideration. When rating alternatives for criterion 2 (treated water quality), the treatment technologies that meet the secondary drinking water criteria, particularly for TDS, are rated highest.

5.0 EVALUATION OF TREATMENT ALTERNATIVES

A number of treatment processes have been identified by EPA as best available technologies (BATs) for treatment of arsenic. This report identifies and evaluates technologies that are specific to As^{5+} because arsenic in the Fallon groundwater is essentially present only in this form. Those processes identified by EPA as BATs for arsenic are listed below:

- Activated alumina
- Coagulation/filtration
- Electrodialysis reversal
- Ion exchange
- Lime softening
- Reverse Osmosis/Nanofiltration.

Each of these processes is evaluated below for application in a centralized treatment plan. The exception is electrodialysis reversal, which is not a cost-effective process, as well as suffering from the same types of limitations as reverse osmosis and nanofiltration which are described in Section 5.1.3. Other processes that are considered in this evaluation are granular ferric hydroxide, metal-oxide coated sand, and granular activated carbon, as well as point-of-use, dual distribution, and alternative supplies.

5.1 Centralized Treatment

The existing distribution system and close proximity of groundwater supply wells support possible utilization of a centralized treatment facility for the City of Fallon. Simply described, this type of a system plan would route pumped water from the city wells into a single supply line that feeds the centralized treatment facility, from which treated water would then be pumped to city storage tanks. Additional optional treatment system plans would be individual well-head treatment systems, which may be cost-prohibitive for some effective technologies, and point-of-use treatment. For evaluation of the following treatment alternatives, it is assumed that each alternative application would occur in a centralized facility.

For sizing purposes, we have assumed that the existing metered water consumption rate of 240 gallons per capita per day (gpcd) is valid for use with 2020 population estimates. Based on a 3

percent annual growth rate from the present population of 8,280, this equates to 3.6 million gallons per day (mgd) in 2020. It is our understanding that existing daily peak demand has reached over 4.0 mgd. While peak demand will also increase as the population grows, the average daily demand is used in this preliminary report. After a treatment technology has been selected, a treatment plant capacity will be calculated based on future average daily and peak demands, and existing and future storage capacity.

5.1.1 Adsorption on Activated Alumina

Activated alumina (AA) is a partially crystalline material consisting primarily of aluminum oxide. It is generated by low-heat dehydration of aluminum hydroxide, a process that increases the surface area and adsorption potential of the material. The mechanism by which AA removes contaminants is often referred to as adsorption, although it is more accurately described as a ligand-exchange process in which hydroxyl (OH^-) ions are exchanged for anionic contaminants. A spent, or exhausted, bed of AA media can therefore be regenerated using a concentrated solution of sodium hydroxide (NaOH).

While most conventional process configurations that employ AA pass the treatment stream through a fixed-bed of granular media, fluidized beds of finer material have also been proposed and tested for enhancement of operational and performance criteria. However, the adsorption kinetics of this media are relatively slow, requiring empty bed contact times (EBCT) varying from 5 to 10 minutes for removal of arsenic, depending on the raw water concentration. For a 2,500 gallon per minute (gpm) flow rate (3.6 mgd), the required volume of AA would be approximately 2,500 cubic feet of media (assuming an EBCT of 7.5 minutes).

5.1.1.1 Effectiveness of Activated Alumina for Arsenate

For drinking water, the effectiveness of As^{5-} treatment with AA has been demonstrated on a pilot-scale for water supplies in San Ysidiro, NM (Clifford, 1999), Albuquerque, NM (Clifford, 1999), Hanford, CA (Clifford, 1999), Fallon Naval Air Station, NV (Hathaway and Rubel, 1987), and Severn-Trent, UK (Simms and Azizian, 1997). At the Fallon Naval Air Station (NAS), Hathaway and Rubel (1987) showed that under controlled operating conditions, arsenate concentrations could be reduced to less than 0.005 mg/L with activated alumina for 8,500 bed

volumes. The groundwater used in their pilot test was from the same aquifer as the City of Fallon, and contained from 0.080 to 0.116 mg/L soluble arsenic. In other pilot tests recently performed in Albuquerque, where soluble arsenic concentrations are approximately half that of the City of Fallon supply, results similar to the Fallon NAS were obtained (Clifford, 1999). Using these reported numbers for AA treatment bed volumes and EBCTs from above, the effective run lengths for a fixed bed of activated alumina would be on the order of one month.

5.1.1.2 Effect of pH

Both the equilibrium adsorption capacity and the treatment capability of AA are dependent on pH. The competition of OH^- at higher pH values and the protonation of arsenate oxyanions at lower pH values dictate an optimum operating pH for AA and As^{5+} in the range of 5.5 to 6.0. Simms and Azizian (1997) found that AA adsorption capacities at pH 7.5 decreased by more than 90 percent when compared to experimental values at pH 6. For the City of Fallon groundwater supply, a significant acid addition would be required to reach an operating pH of 6.0. Based on the present alkalinity measurements of 215 mg/L (4.3 meq/L alkalinity as $CaCO_3$), it is estimated that 4.3 meq/L of acid would be required to neutralize the alkalinity. This corresponds to 1,290 gallons per day of concentrated HCl for a water usage of 3.6 mgd.

5.1.1.3 Effect of Sulfate

When sulfate, chloride, and arsenate are in solution, As^{5+} is preferentially adsorbed. Although the competitive effect of sulfate is not as significant as in ion exchange, this anion does decrease the adsorption capacity if present in significant quantities. Clifford (1999) indicates a 50 percent reduction in AA adsorption capacity for As^{5+} when sulfate levels are increased from 0 to 360 mg/L. Therefore, because chloride ions do not exhibit a significant effect on arsenate adsorption, pH adjustment with HCl would be preferred relative to H_2SO_4.

5.1.1.4 Effect of Regeneration on Capacity

Upon exhaustion of the AA media (the point where a predetermined contaminant concentration is reached), regeneration is accomplished using a caustic solution of 2 to 4 percent sodium hydroxide (NaOH). This high strength of solution is required because arsenic tends to be tightly bound to the AA media and is difficult to elute at lower caustic concentrations. Although

regeneration parameters vary with operation, typical AA regeneration requires 5 bed volumes of NaOH solution followed by 2 bed volumes of acid-neutralization, with intermediate fresh water rinses. As a result of regeneration, the capacity of the resin is usually decreased to 70 to 80 percent of its virgin capacity. In the case of Fallon, the resulting waste solution from regeneration would contain high levels of sodium, sulfate, aluminum, and arsenic. Hathaway and Rubel (1987) found 23 to 41 mg/L arsenic in spent regenerant solutions from their pilot study at the NAS. Treatment of the spent regenerant solution is usually accomplished by adjusting the pH to a point where enough aluminum precipitates to remove soluble arsenic concentrations to an acceptable level.

Thus far, pilot-scale test results have not shown a consistent pattern of data to understand the long-term adsorption effects of successive regeneration on aging media, but data provided by AA suppliers suggest that as much as 3 percent of the media may be dissolved by the concentrated caustic regenerant solution. A 3 percent loss of media during each regeneration would cause a 50 percent loss of the initial mass of media after 23 cycles. Therefore, even though effective run lengths could be as long as a month using fresh AA media, it is a real possibility that the media would have to be replaced more frequently.

5.1.1.5 Implementation

Conventional activated alumina treatment in a centralized facility would include the following process units: AA media vessels, storage and feed equipment for both caustic and acid, spent regenerant processing, residuals handling, and fluoridation equipment (if desired). In addition to arsenate, AA treatment is also highly selective for fluoride (initially present at 0.6 mg/L in Fallon water), which would need to be replenished if residual fluoride concentrations are desired in the product water. Hydrochloric acid would be required for adjusting the highly alkaline raw water to a more suitable operating pH, secondary pH adjustment of regenerated resin, and possibly for spent regenerant treatment. Sodium hydroxide solution would be utilized for final pH adjustment of product water, as well as for AA media regeneration. When compared to other similarly effective treatment processes for arsenic, the operation, handling, and the cost of chemicals in conventional AA treatment are relatively high.

The process operation of the AA treatment technology can be continuous when multiple exchange vessels are employed, particularly given the long run cycles that can be achieved. Full automation and monitoring of this process would be possible without risk of substantial arsenic leakage into the product water if run cycles were preset and the volume of AA media regularly maintained with new material. Product water consumption would occur at the end of run cycles during media backwashing, rinsing and regeneration. The amount of water consumed by this stage of the process would be minimal (<1 percent of the process stream).

Treatment residuals from the AA process would include aluminum-based sludge from treatment of spent regenerant and concentrated supernatant (treated, clarified regenerant) consisting of elevated concentrations of sodium, chloride, and sulfate. Evaporation of the concentrated regenerant would be a likely disposal option, with the dewatered sludge being disposed in an approved landfill, depending on the applicable disposal criteria. However, because little information is available on the stability of aluminum-based sludge containing high levels of arsenic, it is possible that the sludge would be classified as hazardous.

5.1.1.6 Rating of Activated Alumina

The criteria presented on Table 3 have been evaluated for AA and are rated on the following table. A brief explanation of each rating is also provided.

Table 3 Criteria Rating for Activated Alumina

Criterion	Rating	Explanation of Rating
1. Effectiveness	4	95 percent reduction demonstrated for an initial concentration of 0.1 mg/L.
2. Treated Water Quality	1	Substantial TDS increase due to pH adjustments.
3. Water Use/Recovery	3	Water losses due to make-up of regenerant solutions and evaporation of spent solutions are minor.
4. Raw Water Composition	1	Sulfate concentrations diminish adsorption capacities. High pH and alkalinity significantly increase chemical consumption of process.
5. Residuals Management	2	Stability of aluminum sludge unknown. Evaporation required for treated spent regenerant
6. Ease of Operation	3	Process can be automated. Regeneration involves several hazardous chemicals.
7. Initial Cost	3	Process equipment is relatively simple. Media is moderately expensive.
8. Annual Cost	2	Chemical consumption is substantial. Media replacement possible.

5.1.2 Strong-Base Anion Exchange

Modern ion exchange for treatment of trace inorganic contaminants involves utilization of synthetic resins that have high exchange capacities relative to natural forms, such as zeolites. The functional treatment aspect of the process is accomplished by "trading" undesirable ions in solution for others that are more desirable (i.e., one $HAsO_4^{2-}$ for two Cl^-). In practice, anion exchange, which is applicable to arsenic, occurs almost exclusively with synthetic resins. Resins are classified based on their ability to separate salts from solution, with strong-base resins possessing greater separation ability than weak-base resins. It is the functional group, the part of the resin where exchange occurs, that dictates its classification. The functional groups that are associated with anionic resins are quaternary ammonia and tertiary amines, both capable of exchanging either OH^- or Cl^-.

There are two primary aspects to consider in ion exchange operation. The first is the order of selectivity; this is a parameter that indicates which ions will be preferentially removed from solution. In low ionic strength solutions, ions having higher valence states and smaller ionic radii are generally preferred. For the Fallon groundwater, anionic constituents other than As^{5-} that would be relevant to the order of selectivity include sulfate, bicarbonate, and chloride. The other aspect to consider is the exchange capacity, which is a parameter that describes the number of ionic sites per unit weight or volume of resin. This parameter is usually expressed in milliequivalents per gram of dry resin (meq/g). The exchange capacity is an indicator of the mass of contaminant that can be applied to the exchange material before resin exhaustion, and subsequent contaminant breakthrough, occurs. The operating exchange capacity of a resin for a particular water chemistry is one of the most important properties to define when evaluating or designing an ion exchange process.

5.1.2.1 Strong-Base Anion Exchange Effectiveness for Arsenate

Of the two types of anionic resins available, strong-base anion exchange (SBAE) resins are more suitable for removal of arsenic because they operate over a range of pH values. The ability of SBAE treatment to reduce As^{5+} concentrations to very low levels has been clearly demonstrated. Recent test work has shown that for an initial As^{5+} concentration of 0.015 mg/L, in the presence

of chloride, nitrate, and sulfate, effluent arsenic concentrations could be easily maintained below 0.002 mg/L (Ghurye and others, 1999). Using SBAE resins from four different manufacturers, these researchers also demonstrated that effluent arsenic concentrations below 0.001 mg/L could be maintained for each resin.

In work performed by the University of Houston for the City of Albuquerque, using EPA's mobile drinking water treatment research facility, arsenic concentrations were reduced to levels below 0.002 mg/L for run lengths equivalent to 640 bed volumes (Clifford, 1999). This is significant because the groundwater used in that study has similarities to the City of Fallon in that sulfate was measured at 82 mg/L (compared to 87 mg/L at Fallon), in addition to the presence of silica and alkalinity.

5.1.2.2 Effects of Competing Ions

The effect of competing anions, particularly sulfate, is significant in strong-base anion exchange for arsenate. Because sulfate is adsorbed in preference to As^{5+}, and it is normally present in much higher concentrations, this anion can significantly decrease the number of bed volumes that can be treated before breakthrough of arsenic. Other anions that may compete with arsenic are silica, bicarbonate, nitrate, and fluoride, although their effect would be small compared to sulfate.

Ghurye (1999) found that when the influent sulfate concentration was increased from 40 to 100 mg/L, a 2.4-fold decrease in the number of treated bed volumes (before arsenic breakthrough) occurred. However, arsenic leakage (effluent arsenic concentration) through the ion exchange column prior to breakthrough remained below 0.002 mg/L, regardless of the sulfate concentration (which was as high as 220 mg/L). While the presence of sulfate may significantly affect the mode of operation of this process, it does not appear to affect treatment effectiveness. An upper concentration limit of 150 mg/L sulfate is suggested as a criterion for selecting ion exchange for arsenic removal (Clifford, 1999).

5.1.2.3 Peaking Effect at Exhaustion

As the exchange capacity of SBAE resin becomes exhausted (the point when available exchange sites are fully depleted), there is a potential for arsenic to leak through the resin bed at

concentrations that exceed those in the influent (commonly referred to as "peaking"). The peaking effect occurs at exhaustion because sulfate ions, or other preferential anions relative to arsenic, rapidly displace arsenic from exchange sites. Although there are several factors that will have an effect on peaking, data generated by Ghurya and Clifford (1999) suggest that peaking factors (the ratio of peak to influent concentration) become higher as influent sulfate concentrations increase. For sulfate concentrations in the 80 to 100 mg/L range, peaking factors between 2.5 and 4 were observed. In practice, protection against arsenic peaking can be accomplished by designing multiple exchange vessels in a parallel circuit.

5.1.2.4 Implementation

Treatment of arsenic in a centralized facility that utilizes SBAE would include installation of the following units: exchange vessels, backwash and resin regeneration equipment, chemical storage and preparation, spent regenerant solution processing, and residuals handling. Assuming that a chloride-form resin is used, the regenerant solution would likely consist of a 1 to 3 normal solution of sodium chloride. The spent regenerant that requires processing would be a concentrated sodium/sulfate/chloride/bicarbonate solution that contains as much as 10 mg/L arsenic (assuming 1 percent of the process stream is wasted). Before disposal of this solution, presumably involving an evaporation pond, arsenic should be reduced to an acceptable concentration and transferred into a stable residual. Clifford (1999) suggests using conventional coagulants to reduce arsenic levels in spent regenerant solutions. Other possibilities for arsenic reduction in this solution are coprecipitation with gypsum or calcite. Because treatment with ferric iron at high enough doses has been demonstrated to produce a non-hazardous, dewatered sludge (Clifford, 1999), it is assumed that conventional disposal would be possible for this residual.

The process operation of the SBAE technology can be continuous when multiple exchange vessels are employed that have unique backwash/regeneration cycles. Assuming that a high number of bed-volumes can be safely achieved for a typical treatment run (400 bed volumes), this process can be fully automated and monitored without risk of substantial arsenic leakage into the product water. Because the SBAE process requires product water for make-up of regenerant solutions that are eventually disposed of, it would not completely recover the entire influent

stream. For this type of a treatment process, it is estimated that less than 2 percent of the process stream would be wasted.

5.1.2.5 Rating Strong-Base Anion Exchange

The criteria presented on Table 4 have been evaluated for SBAE and are rated on the following table. A brief explanation of each rating is also provided.

Table 4 Criteria Rating for Strong-Base Anion Exchange

Criterion	Rating	Explanation of Rating
1. Effectiveness	4	Highly effective to low concentrations.
2. Treated Water Quality	4	Expect a slight decrease in TDS as chloride exchanges for sulfate and other anions.
3. Water Use/Recovery	2	Water losses due to make-up of salt regenerant solutions and evaporation of spent solutions are minor.
4. Raw Water Composition	2	Increased sulfate decreases adsorption capacity, but does not impact overall effectiveness for arsenic removal.
5. Residuals Management	3	Iron sludge assumed to be non-hazardous. Evaporation required for spent regenerant.
6. Ease of Operation	3	Process can be automated. Regeneration is frequent, but does not involve hazardous chemicals.
7. Initial Cost	3	Process equipment is relatively simple. Media is moderately expensive.
8. Annual Cost	3	Primary chemical, NaCl, is relatively inexpensive. Media replacement is not anticipated.

5.1.3 High-Pressure Membrane Separation

Although the term "high-pressure" is used to describe this treatment alternative, the actual operating pressures normally applied for treatment of groundwater supplies (100 to 250 psi) are much lower than those used in desalting processes (>600 psi). The process of high-pressure membrane separation is distinguished from low-pressure filtration processes by the types of compounds that can be removed. While low-pressure filtration (micro- and ultrafiltration) is usually effective for particulate compounds such as colloids and organic matter, high-pressure filtration (nanofiltration and reverse osmosis) involves the use of semi-permeable membranes that, under sufficient driving pressures, will separate molecular-sized compounds, such as soluble arsenic anions (Brandhuber and Amy, 1998). Another membrane-based process, electrodialysis, is also capable of separating molecular compounds, but is not considered in this

evaluation primarily because the amount of published test work and applications specific to arsenic are limited.

Both nanofiltration (NF) and reverse osmosis (RO) membrane separation processes operate under similar principles that are described by inorganic solute transport models. Extensive theoretical descriptions of these models can be found in textbooks and in manufacturers' guides. In simple terms, these models provide a basis for predetermining, under a given set of conditions, the amount of clean water that can be passed through the membrane (permeate flux) and the percent removal of a particular contaminant (solute rejection). In general, when testing and designing for a high-pressure membrane separation process, the applicable parameters involve membrane module configuration, membrane type and material, operating feed-water pressure, contaminant rejection, and product water recovery.

A typical high-pressure membrane system consists of using multiple-stage pumps to deliver feed water to the membrane surface. The feed water, which is usually pretreated to reduce fouling potential, is separated by the membrane into a permeate stream and a concentrate stream. The ratio of these two streams (described by the recovery rate) is physically dictated by the feed stream water quality (TDS concentration) and the number of stages utilized in the process. Staging refers to the sequential passage of the concentrate stream through different membrane modules. Typically, the degree of permeate flux and solute rejection decreases for each successive stage. In high water-demand areas where a high percentage recovery of the feed water stream is essential, a multiple-staged process would be used to maximize the permeate stream flow rate.

5.1.3.1 Effectiveness of High-Pressure Membrane Separation for Arsenic

The ability of high-pressure membrane separation processes to remove arsenic from solution has been understood for several decades. Early test work performed using reverse osmosis membranes showed that As^{5+} removals (>90 percent) were much higher than for As^{3+} (<70 percent) (Huxstep and Sorg, 1981; Schneiter and Middlebrooks, 1983). More recent work utilizing advanced membrane materials (aromatic polyamide composites) indicate that As^{5+} removals greater than 95 percent, and up to 99 percent, can be achieved under a variety of operating conditions (Waypa and others, 1997). Waypa and others (1997) showed that at pH 8

and a feed water As^{5+} concentration of 0.05 mg/L, rejections exceeding 97 percent could be consistently achieved by both NF (80 psi) and RO (200 psi) membranes at 20 °C (rejection increases at lower temperatures). This type of performance was demonstrated in both low and high (2,000 mg/L) TDS solutions. These tests were conducted only as single-stage processes and therefore did not provide solute rejections for As^{5+} under multi-stage, high-recovery conditions.

5.1.3.2 Effect of Increased Recovery Rates

Due to limitations in water use and recovery, the application of high-pressure membrane separation to the City of Fallon would require that high permeate recoveries be employed for this process. As discussed above, increasing process recovery rates can be accomplished by staging the membrane system to provide a sequential reduction in the amount of concentrate stream flow. Potential decreases in As^{5+} rejection can occur as the characteristics of the concentrate solution change at each successive stage. Although the degree of this occurrence is difficult to predict, it is more certain that the concentration of As^{5+} in the permeate stream will increase as the constituent level in the concentrate stream increases, assuming a consistent solute rejection percentage at each stage. For example, at high recovery rates the level of As^{5+} in the concentrate stream may approach 0.5 mg/L, which would result in permeate concentrations in the range of 0.01 to 0.02 mg/L (assuming 97 percent rejection). This type of analysis suggests that achieving high recovery rates (to minimize water losses) may prohibit this technology from meeting a 0.005 mg/L standard.

5.1.3.3 Solubility Limitations on Recovery

As recovery rates increase so does the potential precipitation of sparingly soluble salts, and concomitant fouling of the membranes. The scaling compounds that are usually of greatest concern are $CaCO_3$, $CaSO_4 \cdot 2H_2O$, CaF_2, $BaSO_4$, $SrSO_4$, and SiO_2. Because of the low concentrations of calcium, barium, and strontium in the City of Fallon groundwater supply, silica would be the most important constituent to consider. At an initial concentration of 28 mg/L, silica would be predicted to be present at concentrations above saturation for membrane processes operating at high recovery rates and high rejection. However, with the use of anit-scalants, a common practice to protect membrane elements and provide efficient operation, it may be possible to counter potential scaling from silica.

5.1.3.4 Implementation

For complete recovery of feed water to a high-pressure membrane separation facility, the following system units would likely be required: pretreatment pH adjustment and microfiltration, an array of multiple-stage NF or RO membranes, concentrate stream treatment processing, and residuals handling. Complete recovery of the process influent stream could be accomplished by maximizing the permeate recovery (≥80 percent), treating the concentrate stream for arsenic, and blending the two to produce an effluent stream that has low residual arsenic concentrations.

Assuming that an 80 percent recovery by the NF or RO membranes could be accomplished, the treatment process for arsenic in the concentrate stream would be an approximate 0.7 mgd, continuous-flow precipitation process that utilizes ferric chloride or alum (in addition to clarification and filtration). Depending on the level of arsenic achieved by the concentrate recycling, and to a lesser degree the As^{5+} rejection by the high-pressure membranes, the product water from the concentrate treatment could either be blended with the membrane permeate or recycled back to the membrane feed stream. Because salts, in the form of pH adjustment chemicals and coagulating agents, would build up in the process as a result of recycling, the most feasible operation of this system would require adequate removal of As^{5+} from concentrate to allow blending with the membrane permeate.

The design of membrane separation processes are typically modularized for ease of operation and maintenance. As permeate fluxes decline over extended operation, membrane modules occasionally need to be taken off line and cleaned to remove potential fouling material such as biofilms and scales, or to replace damaged membrane elements. By modularizing, continuous process operation can be maintained while individual modules are cleaned, regenerated, or replaced; this also simplifies troubleshooting for potentially damaged elements. Full automation and process monitoring can be achieved using a central control station.

The most difficult operational aspect of this type of process is achieving complete recovery of the feed water stream. This is because the high coagulant doses required for treatment of the expected arsenic concentrations (approximately 0.5 mg/L at 80 percent recovery) in the concentrate stream would increase the potential for process upset or arsenic spikes in the blended

water. Also, since the ratio of coagulant dose (for a specified level of removal) to initial arsenic concentration usually decreases as initial arsenic concentrations increase, the amount of coagulant and mass of residual produced in this step would be less than that expected for enhanced coagulation process that treats the entire influent stream. Because the dewatered sludge from concentrate treatment would be similar to that for SBAE regenerant treatment, it is assumed that conventional disposal would be possible.

5.1.3.5 Rating High-Pressure Membrane Separation

The criteria presented on Table 5 have been evaluated for high-pressure membrane separation and are rated on the following table. A brief explanation of each rating is also provided.

Table 5 Criteria Rating for High-Pressure Membrane Separation

Criterion	Rating	Explanation of Rating
1. Effectiveness	1	95 to 99 percent arsenate rejections are possible for a single-stage system. Multiple stages will concentrate arsenic and increase permeate concentrations.
2. Treated Water Quality	2	For concentrate treatment and blending scenario, TDS concentrations would be expected to increase slightly.
3. Water Use/Recovery	3	Effective treatment and blending of concentrate stream would allow almost complete recovery.
4. Raw Water Composition	3	Concentration effects at high recovery rates may cause scaling.
5. Residuals Management	3	Iron sludge assumed to be non-hazardous. Evaporation not necessary if treated concentrate can be blended.
6. Ease of Operation	2	Process can be automated. Monitoring staged recoveries and effect on concentrate treatment is difficult.
7. Initial Cost	2	Requires relatively large number of treatment units and membrane arrays to achieve high permeate recoveries.
8. Annual Cost	2	Power demand for membrane operation is high. Chemical requirement for concentrate treatment is high.

5.1.4 Enhanced Metal Coagulation

The process of chemical coagulation involves the addition of metal salts that dissolve, undergo hydrolysis, and form precipitates in the treatment stream. Conventional metal salts in drinking water treatment include alum (aluminum sulfate) and ferric chloride, although lime, ferrous sulfate, aluminate, silica, and aluminum chloride have also been applied. The amorphous precipitates that form during coagulation provide adsorption sites for oppositely charged

particles or molecules. These charged compounds can then be removed from solution by attachment to the precipitates, a mechanism referred to as surface complexation, facilitating physical removal by sedimentation and/or filtration.

In conventional coagulation, metal salts are added to solution in sparing amounts such that colloidal material is destabilized, allowing it to be physically removed. Enhanced coagulation, first employed as a method to remove natural organic material, involves the addition of excess chemical and adjustment of pH for maximizing the amount of adsorption sites for surface complexation of a target constituents, particularly trace inorganic contaminants. Adjusting the solution pH changes the ionic form of the constituent to be removed as well as the density of adsorption sites of the coagulant.

5.1.4.1 Enhanced Coagulation Effectiveness for Arsenate

The concept of enhanced coagulation for treatment of arsenic has been tested for decades. Early jar-testing showed that at moderate coagulant doses and at near-neutral pH values arsenate could be easily removed from solution in percentages exceeding 96 percent (Gulledge, 1973). These tests also showed that ferric iron was more effective for treatment of arsenic than alum. More recent bench-scale and pilot testing has confirmed that ferric iron is more effective for adsorption of arsenate (Cheng, 1994). Cheng found that in treatment of surface water containing spiked As^{5+} concentrations as high as 0.128 mg/L, greater than 99 percent removal was achieved using 30 mg/L ferric chloride. Results for similar tests using alum indicated a strong dependence on pH for effective treatment and a much lower removal percentage (57 percent) than ferric iron. Subsequent testing of arsenic removal by enhanced coagulation has therefore focused on ferric iron (Scott, 1995).

5.1.4.2 Effect of pH

The optimum pH range for adsorption of As^{5+} using ferric iron as a coagulant is 5 to 7. Coagulation experiments using an iron to arsenic molar ratio of 112:1 showed percentage removal of As^{5+} to decline from near 100 percent at pH 8 and lower, to approximately 80 percent at pH values near 9 (Hering and others, 1996). Research models predict that As^{5+} removal efficiency is more dependent on pH than coagulant dose, suggesting that percent removals will

drop off significantly above pH 8.5 (Edwards, 94). Although the published data indicate that ferric iron is the most effective coagulant over a wide range of pH values, it is clear that a solution pH of 8 or less would be required for high percentage removals (>95 percent) of As^{5+}. Other test work using high initial arsenate concentrations suggest that a pH of 8 is the approximate upper limit for efficient removal (Wang, 2000). Preliminary field experiments on Fallon groundwater by SMI show that a portion of the necessary reduction in pH may be achievable by a simple aeration process.

In the case where the starting pH of Fallon water is 9.16, it is apparent that a reduction of the raw water pH would be necessary to attain high removal efficiencies with ferric iron coagulation. Because ferric iron generates acidity upon hydrolysis, the operating pH during enhanced coagulation would be less than the raw water pH. However, for the groundwater supply in Fallon, neglecting possible benefits from aeration, this acidity generation would be buffered by the existing alkalinity concentrations (approximately 4.3 meq/L). To achieve an operating pH near a value of 8, initial carbonate (CO_3^{2-}) concentrations indicate that approximately 0.4 meq/L of acidity (complete conversion of 0.4 mmoles/L CO_3^{2-} to HCO_3^-) would be required. Therefore, because the acidity generated by ferric iron hydrolysis would likely exceed the acidity predicted to be required for sufficient pH reduction (i.e., pH 8), a separate addition of acid would probably not be required.

5.1.4.3 Effects of Competing Ions

The presence of sulfate, silica, and carbonate species may have a negative impact on the overall treatment effectiveness of ferric iron coagulation for removal of arsenate because these ions may compete for adsorption sites. While laboratory studies have shown sulfate (as high as 250 mg/L) and carbonate species to have negligible effects on arsenate removal, the impact of silica is greater (Meng and others, 2000). Meng showed that in the presence of 21 mg/L silica (10 mg/L silicon) and at a pH of 6.8 the adsorption density of As^{5+} to ferric iron was reduced by a third. This effect was attributed to a reduced number of surface adsorption sites available to arsenic. However, at higher ferric iron concentrations (an approximate 13.5:1 molar ratio to arsenic), the effect of silica was determined to be insignificant below pH 7. This information is consistent with laboratory work performed by the University of Houston for the City of Albuquerque.

The level of phosphate (0.22 mg/L as phosphorous) in the Fallon groundwater appears to be too low to have a significant impact on ferric iron coagulation. The literature shows phosphate (at 25 mg/L) to have an negligible effect on arsenic removal at pH 9, but the data also indicate that in the presence of calcium (120 mg/L) and phosphate, adsorption of As^{5+} increased (Hering and others, 1996).

5.1.4.4 Implementation

Treatment of As^{5+} by enhanced coagulation with ferric iron would require construction of a centralized treatment facility that employs the following units: rapid mixing and flocculation, sedimentation, filtration, chemical feed systems, and residuals processing. The ferric iron coagulant concentration and type of filtration would influence the requirement for a sedimentation unit; this unit would provide primary clarification prior to filtration. Residual processing would entail sludge thickening and dewatering components to reduce the volume and mass of sludge to be disposed. While most sludges generated in coagulant process are non-hazardous (TCLP compliant), the high level of arsenic to be removed from the Fallon water supply may alter this character. This is important because disposal in a designated site for hazardous materials would significantly impact overall sludge disposal costs. Until tests are performed on a typical sludge sample, it is assumed for this evaluation that conventional disposal in a local landfill would be acceptable. Liquid process residuals would not be generated by enhanced coagulation.

The possibility of process operation interruption would only occur during backwashing of filtration units. By modularizing filtration units into multiple compartments, continuous process operation could be maintained while individual filtration units are backwashed and cleaned. Full automation and process monitoring can be achieved using a central control station. Because arsenic is physically removed from the product stream and waste solutions are not produced, complete recovery of the influent stream would be a likely scenario for this process.

5.1.4.5 Rating Enhanced Coagulation

The criteria presented on Table 6 have been evaluated for enhanced coagulation and are rated on the following table. A brief explanation of each rating is also provided.

Table 6 Criteria Rating for Enhanced Coagulation

Criterion	Rating	Explanation of Rating
1. Effectiveness	3	Capable of achieving concentrations below 0.005 mg/L.
2. Treated Water Quality	2	TDS increased slightly from iron salt addition and possible pH adjustment.
3. Water Use/Recovery	3	Complete recovery of influent stream possible.
4. Raw Water Composition	4	Potential interference from silica and phosphate easily handled by minor operating adjustments.
5. Residuals Management	4	Iron sludge assumed to be non-hazardous – only waste stream.
6. Ease of Operation	3	Full automation and continuous operation possible.
7. Initial Cost	4	Required process units have a relatively low cost.
8. Annual Cost	4	Iron coagulant, the primary chemical, is relatively inexpensive. Power demand for filtration and filter replacement are anticipated to be minimal.

5.1.5 Adsorption onto Granular Ferric Hydroxide

Granular ferric hydroxide was recently introduced for drinking water applications specific to arsenic (Driehaus and others, 1998). The process relies on the adsorption capabilities of hydrous ferric oxides, and can be utilized in fixed-bed media reactors. Even though the technology is still considered to be in the development phase as adsorption capacities and regeneration potentials are being refined, preliminary data generated by Driehaus and others (1998) indicate a high potential effectiveness for As^{5+}. In these tests, this material demonstrated adsorption capacities for As^{5+} as high as 8.5 g/kg of media (a range of 3.2 to 8.5 g/kg was determined for several tests), and bed volume capacities that exceeded 30,000 (to 0.01 mg/L). Some competing anions (phosphate) exhibited an effect on As^{5+} adsorption, while others did not (sulfate and chloride). The effect of pH on adsorption to granular ferric hydroxide does not appear to be as significant as that observed for activated alumina. Significant removal efficiencies were observed at an operating pH of 7.8.

Given that the granular ferric hydroxide appears to have relatively large bed volume capacities, long treatment runs could be achieved with this media. At exhaustion, the recommended method for managing the media is landfill disposal because the potential for efficient regeneration appears limited. However, the relatively high cost of the material may prohibit direct disposal as an option and potentially favor regeneration as the preferred management option. Preliminary

costs provided by one North American supplier of granular ferric hydroxide are estimated to be in the range of $20,000 to $25,000 per ton. Assuming a 3.6 mgd treatment facility, initial arsenic concentrations of 0.1 mg/L, and an adsorption capacity of 8.5 g/kg, this translates to approximately $1.3 million per year for media replacement alone.

5.1.5.1 Rating Granular Ferric Hydroxide

The criteria presented on Table 7 have been evaluated for granular ferric hydroxide and are rated on the following table. A brief explanation of each rating is also provided..

Table 7 Criteria Rating for Granular Ferric Hydroxide

Criterion	Rating	Explanation of Rating
1. Effectiveness	2	95 percent reduction is possible, but not clearly demonstrated.
2. Treated Water Quality	3	Slight increase in TDS from initial pH adjustment.
3. Water Use/Recovery	4	Complete recovery possible if media not regenerated.
4. Raw Water Composition	3	Possible interference of competing anions, such as phosphate.
5. Residuals Management	2	Frequent disposal of media required if regeneration not possible.
6. Ease of Operation	4	Process operation similar to AA and SBAE. Regeneration not needed if media is replaced at exhaustion.
7. Initial Cost	1	Cost of media is projected to be high.
8. Annual Cost	1	Disposal of exhausted media would require relatively frequent replacement at high cost.

5.1.6 Adsorption onto Metal-Oxide-Coated Sand

Metal-oxide-coated sand represents an innovative process for adsorption of aqueous arsenic species. The coated sand grains are generally prepared by mixing with metal solutions, drying at various temperatures to form different degrees of crystallization, and cleaned with distilled water. The operation of this technology for full-scale treatment is presumed to be similar to other adsorption processes, in which water is passed through a fixed bed of media. For As^{5+}, metal-oxide-coated sand has been shown to be most efficient at slightly acidic pH values for extended contact times, and when natural organic matter (a significant competitor for adsorption sites) is not present tests (Benjamin and others, 1996).

The technology is particularly attractive because it represents treatment in a single system unit that utilizes a relatively inexpensive media. The downside is that the technology has not been

extensively studied, and the lack of reliable, available information in the literature suggests that this is a poorly understood process for full-scale implementation. In different laboratory studies, both Fe^{3+} and Mn^{4+} have been used as sand coatings in which removal efficiencies and breakthrough bed volumes were determined by column tests (Joshi and Chaudhuri, 1996; Bajpai and Chaudhuri, 1999). The key finding in these column tests was that for initial arsenic concentrations of 1.0 mg/L and extended contact times (50 to 75 minutes), both iron- and manganese-coated sand reduced concentrations to below 0.01 mg/L ($\geq$99 percent) for approximately 150 bed volumes. During successive test runs to breakthrough concentrations, regeneration of the coated sand with 0.2 normal NaOH solution was able to recover approximately 95 percent of the adsorbed arsenic. In other test work, where the number of treated bed volumes was significantly higher, release of arsenic from the media during regeneration was poor (<50 percent), suggesting that successive run cycles will have substantially reduced run times (Benjamin and others, 1996).

Based on a limited amount of data, the metal-oxide-coated sand technology appears to be a highly effective process that has potential for reducing As^{5+} concentrations from 0.1 to 0.005 mg/L. Although the available published data indicate positive test results, many data gaps regarding the full-scale implementation of this technology have yet to be adequately determined, such as:

1. The effect of preparation methods on adsorption capacity
2. Optimization of contact times for high initial arsenic concentrations
3. Loss of metal coating during operation and regeneration
4. Long-term effects of poor regeneration
5. Chemical stability and disposal of spent media.

Because many of the important parameters relevant to this technology are currently unknown, evaluation and comparison of this alternative is impossible. Therefore, using the lack of necessary information for this process as a basis, despite its apparent effectiveness for As^{5+}, metal-oxide-coated sand is not evaluated further.

5.1.7 Lime Softening

Softening of water with lime involves precipitation of calcium (as $CaCO_3$) and magnesium (as $Mg[OH]_2$) by increasing the solution pH (with lime, $Ca[OH]_2$) to a point where these minerals are least soluble. Although As^{5+} removal during lime softening has been proposed to occur by adsorption mechanisms or formation of arsenic-bearing solids, more recent data indicate that it is adsorption processes (McNeill and Edwards, 1997) that account for its removal, particularly when $Mg(OH)_2$ is generated. These recent data indicate that effective As^{5+} removal (>90 percent) occurs when solution pHs exceed 11, in the region where $Mg(OH)_2$ forms (significant calcite formation occurs at pH 10 and above), and the degree of As^{5+} removal by calcite was found to be limited (approximately 30 percent). In addition, full-scale treatment plant data, which show increasing As^{5+} removal with increasing pH, support removal induced by $Mg(OH)_2$ precipitation (McNeill and Edwards, 1995).

Although the City of Fallon groundwater contains sufficient alkalinity to form calcite (assuming the addition of calcium as $Ca[OH]_2$), the initial level of magnesium (0.5 mg/L) would significantly limit the amount of $Mg(OH)_2$ available for adsorption of As^{5+}. McNeill and Edwards (1997) found that when adding 0.5 mg/L Mg (as preformed $Mg[OH]_2$) to solutions containing various concentrations of As^{5+} (0.005 to 0.16 mg/L), a consistent removal efficiency of 37 percent was observed, far below that required for an initial concentration of 0.1 mg/L arsenic.

Without a pretreatment addition of magnesium to the groundwater supply, it appears that a sufficient reduction in arsenic concentrations is infeasible with lime softening. In addition, because the highest arsenic removal efficiencies are achieved at very high pH values (>11.5), where the highest negatively-charged arsenate species (AsO_4^{3-}) predominate, a considerable amount of acid would be required to return the pH back down to an acceptable range (6.5 to 8.5) (Kartinen and Martin, 1995). Therefore, using the current Fallon groundwater quality as a basis, As^{5+} removal by lime softening is not rated, and will not be evaluated further.

5.1.8 Granular Activated Carbon

The traditional application of activated carbon has typically been limited to removal of organic hydrocarbons, chlorine compounds, and other organic material that affect the aesthetic qualities

(taste, odor, color) of drinking water. The mechanism of removal for this material is adsorption, which is highly effective due to its highly-porous structure and large surface areas, in addition to the density of functional adsorption sites that result from activation (a process of oxidation at high temperature). Granular activated carbon is used in water treatment in the form of a fixed bed where water can flow through the media by gravity or under pressure. Like most adsorption media, activated carbon has a finite adsorption capacity that, when exhausted, can be replenished by reactivation. While conventional reactivation of activated carbon consists of dehydration, thermal degradation and volatilization of adsorbed compounds, and oxidation at high temperature, the reactivation process for inorganic compounds would require an additional step to desorb metal compounds, presumably with a high-strength acid.

The amount of test work data available for removal of As^{5+} with granular activated carbon is limited. Early literature on the subject predicted a high adsorption potential for arsenic by activated carbon, primarily due to the presence of arsenate as an anion in moderately acidic solutions (Sigworth and Smith, 1972). However, subsequent test work conducted has indicated that As^{5+} adsorption by this material is moderate (Kuhlmeier and Sherwood, 1996; Huang and Vane, 1989). In batch tests, using a variety of granular and powdered activated carbons from several manufacturers, Huang and Vane (1989) found that in the pH range of 6 to 8, As^{5+} removal after 4 hours of contact ranged from less than 10 percent to a high of 85 percent. This test work also found that adsorption of As^{5+} by activated carbon was enhanced by first precoating the media with ferrous iron. Other researchers have also found that activated carbon, while moderately capable of removing As^{5+}, is made most effective when activated by metals (Rajakovic and Mitrovic, 1992).

The granular activated carbon process has not been demonstrated to be effective ($\geq$95 percent) for As^{5+}. It only approaches highly efficient removal at long contact times and at an acidic pH (4 to 5) (Huang and Vane, 1989). The limited data that are available for As^{5+} treatment with the granular activated carbon process, and its apparent moderate effectiveness, preclude further evaluation of this alternative treatment process.

5.2 Point of Use Treatment

Point of use (POU) treatment would be accomplished by installation of a contaminant control device at the point of consumption, such as a kitchen tap in a private residence. The utilization of POU systems is most common for communities where the water supply comes from private wells, or when centralized treatment does not present itself as cost prohibitive. The primary advantage of a POU system is that the volume of water requiring treatment is reduced to a fraction of the total demand. Potential disadvantages are individual system monitoring, replacement of treatment units, inadvertent usage of untreated water from outside taps, and continuous public education.

Another alternative related to POU systems is point of entry (POE) treatment, where the contaminant control device is placed at the user's main supply line and all water entering the residence is treated. This approach eliminates the possibility of inadvertent use of untreated water. However, due to the increased amount of water that would require treatment in a POE-based system, its size would be significantly larger (and more costly) than a POU system. The principal application of a POE system would be for cases in which skin adsorption and inhalation pathways of the contaminant are important, particularly when centralized treatment is not a viable alternative. Because this is not the case for arsenic, further evaluation of POE systems is not warranted.

For arsenic, POU systems have been evaluated using activated alumina, ion exchange, and reverse osmosis technologies (Fox and Sorg, 1987; Fox, 1989). Under proper operating conditions, these technologies are particularly effective for As^{5+}, as discussed in previous sections. This represents a potential advantage to the City of Fallon, because the groundwater arsenic is exclusively As^{5+}, suggesting that if POU systems are employed, pretreatment pH adjustment is all that would be required. Pretreatment pH adjustment would likely be applied to the entire water supply because adequate control of chemicals and operating pHs at each household would be difficult, particularly for intermittent operation.

Of the three technologies demonstrated by Fox (1989), activated alumina and ion exchange would be considered most suitable for a POU system for the City of Fallon. Reverse osmosis is unattractive because this technology is most effective at pressures that exceed the current

distribution system operating pressures. For effective application of RO, booster pumps would be required at each system unit. In addition, expected low recovery rates (<20 percent) through the RO membranes would result in substantial water losses. There would also be potential concerns from using activated alumina and ion exchange in POU systems. In particular, activated alumina may entail significant chemical consumption for adjustment of pH to produce effective treatment, and use of ion exchange would entail the risk of peaking concentrations upon exhaustion.

The responsibility of maintaining a POU-based system would lie with the public water supplier. These responsibilities would include monitoring, repair, replacement, and managing the exhausted materials. Managing the spent media may involve building a facility for regenerating media and disposing of arsenic residuals, or it may involve contracting with a supplier that handles these services. A program of continuing public education would also be needed. The approach taken for managing these aspects of a POU-based system would depend on the reliability of the technology, acceptable risks, and potential costs.

5.2.1 Rating Point of Use Treatment

The criteria presented on Table 8 have been evaluated for point of use treatment with ion exchange and are rated on the following table. A brief explanation of each rating is also provided.

Table 8 Criteria Rating for Point of Use Treatment

Criterion	Rating	Explanation of Rating
1. Effectiveness	4	Concentration reductions to 0.005 mg/L have been demonstrated.
2. Treated Water Quality	3	TDS may decrease slightly for ion exchange, increase slightly for activated alumina.
3. Water Use/Recovery	3	Minimal water loss at point-of-use. Some water losses would occur during processing of spent media.
4. Raw Water Composition	2	The effects on IX and AA are moderate.
5. Residuals Management	1	Collection and regeneration of spent media from individual systems involves high labor costs.
6. Ease of Operation	1	Although the resident assumes operation, the City assumes responsibility for maintaining operation and performance and education.
7. Initial Cost	2	Purchase and installation of individual systems correlates to a high unit cost.
8. Annual Cost	2	System monitoring costs are relatively high when compared to centralized treatment.

6.0 ALTERNATIVE WATER SUPPLIES

Another option for the City is to utilize a water source having a lower concentration of arsenic such that water treatment for arsenic removal is not required. This new water source could be used alone to eliminate the need for treatment altogether (other than disinfection), or mixed with the existing water source to greatly reduce treatment costs. Potential water sources have been investigated by others (Water Research & Development, Inc., 2000) for quantity, quality, and availability. The WRDI report summarizes the potential of using surface and/or groundwater obtained from the Lahontan Valley as well as groundwater obtained from Dixie Valley.

Based on the WRDI report, SMI concludes that these alternate water supplies would be at least as problematic as the City's existing water supply. The Lahontan surface water alternatives are all impacted by recent court decisions. If these court decisions are enacted, Lahontan surface water would not be available for the city's use due to prior appropriation. Even if these surface waters were available, the water wold have to be transmitted a considerable distance to Fallon, then treated to comply with provisions of the Safe Drinking Water Act, the Surface Water Treatment Rule, and potentially the Enhanced Surface Water Treatment Rule (currently being developed by EPA). These regulations would require extensive treatment of the Lahontan surface water, including disinfection (possibly by means other than chlorination), and filtration at a minimum. These treatment costs, in addition to the transmission costs, are estimated to be much larger than those costs for arsenic removal in the City's existing supply.

The groundwater from the Lahontan Valley is also over-appropriated, assuming the recent court decisions are enacted (Water Research & Development, Inc., 2000). Even if these groundwaters were available, they would also have to be treated for arsenic removal because the total arsenic values measured in some of the valley wells range between 0.02 and 0.33 mg/L.

Groundwater from Dixie Valley is currently available for appropriation. Total arsenic values average 0.02 mg/L, but fluoride values in some of the wells exceed the MCL. Therefore, this water likely would also have to be treated for arsenic removal (depending on the final standard), and potentially fluoride removal. In addition to water treatment, this water would have to be transmitted to Fallon through a pipeline system over 25 miles long.

Based on our review of these alternative water sources, SMI does not recommend using an alternative water source to replace or augment the city's existing water supply.

7.0 POTABLE WATER USE REDUCTION

As the city's population grows, potable water demand will increase. As stated previously, the projected average daily demand in the year 2020 is 3.6 mgd. This estimate is based on an annual population growth rate of 3 percent from the current population of 8,280, and the existing metered water consumption rate of 240 gpcd. In order to reduce the average daily consumption rate, as well as the peak demand, a dual distribution system could be implemented within the existing service area and areas of new development. This dual distribution system could deliver treated water for potable use, and untreated water for irrigation and other non-potable water requirements.

A dual distribution system would consist of two pipelines delivering treated and untreated water to each water user. Instead of using treated potable water for irrigation, stock watering, washing driveways, sidewalks, etc, untreated water obtained from the second delivery pipeline would supply this demand.

A dual delivery system would require extensive retrofitting of the existing water distribution system. This would include adding a second pipeline and associated storage, valves, and other appurtenant equipment. For new areas of development, the dual distribution system could be constructed during the time of development. This would also require adding new pipelines from the water supply wells to the areas of new development, as well as storage capabilities.

While a dual distribution system could reduce the size of a future water treatment plant, it would require significant capital investment in new delivery system infrastructure. Developing the costs associated with this new infrastructure is beyond the scope of this report. However, SMI recommends this method of reducing future water demand, and thus reducing the capacity of a future water treatment plant, should be evaluated further.

8.0 COMPARISON OF RATED ALTERNATIVES

The alternatives identified have been evaluated for criteria applicable to this level of screening (Table 2). The available literature indicate that consistently achieving greater than 95 percent arsenic reduction in the City's drinking water supply is possible using several demonstrated treatment technologies. Other innovative technologies appear to have promise, but their limited application makes it difficult to evaluate on a comparative level. For those technologies that were rated using Table 2 criteria, a summary of all results is provided in Table 9 below.

Those technologies that were evaluated, but have not been demonstrated to be adequately effective for As^{5+}, or had limited information available, were not rated and therefore eliminated from further evaluation. As described earlier, a scale of 1 to 4 was used, with "1" indicating the lowest rating, and "4" indicating the highest relative rating among the alternatives rated. The rationale for each score is presented in the specific alternative section.

Table 9 Ratings Comparison for Suitable Technologies

	CRITERIA RATINGS								Total
ALTERNATIVE	1	2	3	4	5	6	7	8	
Activated Alumina	4	1	3	1	2	3	3	2	19
Strong-Base Anion Exchange	4	4	2	2	3	3	3	3	24
High-Pressure Membrane Separation	1	2	3	3	3	2	2	2	17
Enhanced Coagulation	3	2	3	4	4	3	4	4	27
Granular Ferric Hydroxide	2	3	4	3	2	4	1	1	20
POU System	4	3	3	2	1	1	2	2	18

(1) Ability to consistently meet a treated arsenic standard of 0.005 mg/L?
(2) How will the alternative affect the overall product water quality?
(3) How much water is wasted in the process?
(4) Is process effectiveness significantly affected by raw water quality?
(5) Potential impact of handling and disposal of treatment residuals.
(6) Ease of process control, automation, and operation.
(7) Initial estimated capital costs.
(8) Estimated operational, maintenance, and improvement costs.

As Table 9 indicates, two treatment alternatives are clearly rated higher than the others, strong-base anion exchange and enhanced coagulation. Enhanced coagulation received the highest rating of all alternatives primarily because: (1) it is expected to consistently achieve treated water As^{5+} concentrations below 0.005 mg/L, (2) it wastes negligible amounts of water and produces

only one waste stream, (3) its effectiveness is least affected by changes in raw water composition, and (4) it is probably the lowest cost alternative from both a capital and operating standpoint. The main factors of concern for this alternative would be the slight increase in TDS resulting from both pH adjustment and coagulant salt addition, and the relative size of a centralized facility which in practice can be slightly larger than the other alternatives discussed. Bench and pilot-scale testing would adequately address these potential concerns. Assuming effective As^{5+} reductions could be achieved at a higher than optimum operating pH (approximately 8) for moderate coagulant doses, increased TDS concentrations would be minimal. Additionally, the necessity of a large plant footprint for this process can, in theory, be decreased because of the wide range of effective filtration process configurations that are currently available.

Strong-base anion exchange is rated high principally because: (1) it is expected to achieve very low effluent As^{5+} concentrations, (2) it is the only alternative that will reduce effluent TDS, and (3) it can be efficiently regenerated with relatively inexpensive, easy to handle chemicals. The only factors of concern for strong-base anion exchange are the limiting effects of sulfate on operating run times and management of spent regenerant brine solutions. Although the exchange of sulfate for chloride ions from the resin will produce a slight decrease in the TDS of the treated effluent, this process will require more frequent regeneration because sulfate consumes part of the resin exchange capacity. The volume of spent regenerant brine solution that would require handling and disposal is estimated to be less than 2 percent of the process stream, but could be significantly less if effectively recirculated and reused.

The other alternatives were ranked in descending order as follows: granular ferric hydroxide, activated alumina, POU system, and high-pressure membrane separation. High-pressure membrane separation, although demonstrated to be highly effective in a single-stage configuration, received lower ratings because it could only be evaluated as multiple-stage process. A single-stage configuration, which would recover only a minor fraction of the process stream, is an unacceptable alternative for a water-scarce region. As such, a multiple-stage configuration would consist of separate, continuous treatment processes, one for concentrating dissolved As^{5+} into a smaller stream (assumed to be 20 percent of influent flow) and a second for

removing the elevated arsenic from the concentrate stream. The difficulty of maintaining consistent, effective operation, and the cost of equipment for the continuous, parallel streams would be relatively high. In addition, there would be a considerable possibility that the final blended effluent from these two streams would not meet a 0.005 mg/L arsenic standard. These factors are reflected in the low ratings for criteria 1, 6, 7, and 8 for high pressure membrane separation.

Both granular ferric hydroxide and a POU system are attractive because they represent relatively simple operational alternatives. The granular ferric hydroxide alternative received a high rating for criterion 6, primarily because the exhausted media would be disposed, not regenerated. While this alternative was rated high for many of the other criteria, it is ultimately the cost for the material that produces a lower total rating. The POU system alternative, although relatively simple to operate, received a low rating for criterion 6 because the amount of record keeping, education, maintenance, monitoring, and frequency of replacement would be complicated. These same factors directly affect the ratings for residuals handling and system costs for the POU alternative.

Activated alumina received the highest rating for treatment effectiveness because this technology has been clearly demonstrated for groundwater quality similar to the City of Fallon. However, the overall rating for this alternative was one of the lowest, primarily because criteria that are affected by the anticipated high chemical consumption of this process received low ratings. The AA process typically requires a relatively large amount of chemicals to regenerate, but in the case of Fallon would require an unusually large amount to overcome the high groundwater alkalinity needed to attain an operating pH of 6. While the chemical consumption factor has the most significant impact on the operational cost rating of this alternative, it also has an indirect negative effect on criteria 2 (product water quality) and 3 (influence of raw water quality) ratings. Other factors inherent to the AA process such as probable loss of media and capacity during regeneration, unknown arsenic stability in aluminum-based sludge, and the necessary use of hazardous process chemicals all have a considerable negative effect on the ratings.

9.0 SUMMARY AND RECOMMENDATIONS

Several treatment alternatives were evaluated for removal of soluble arsenic from the City of Fallon groundwater supply. The alternatives that were evaluated have been identified by EPA as BATs for arsenic, or are emerging technologies that are demonstrated to be effective for this contaminant at bench- or pilot-scale testing. This evaluation is based on a set of criteria that cover relative factors such as process water consumption, treatment residuals, ease of operation, and costs. Using recent validated groundwater data analyses, relevant published information, and professional experience as a framework, the set of evaluation criteria has been rated for each of the treatment alternatives.

The overall rating for each of the treatment alternatives has been compared to identify those technologies most suited for the City of Fallon. Several of the alternatives were not rated using the eight evaluation criteria. The primary reasons for eliminating these alternatives from further consideration were: (1) limited available performance data, (2) relative ineffectiveness for As^{5+} removal, or (3) impractical implementation. Of the alternatives that were evaluated using the eight criteria, two alternatives were identified, by higher total ratings, as technologies having the best potential for Fallon: (1) enhanced coagulation, and (2) strong-base anion exchange. These two treatment technologies would be both relatively easy to implement and operate, have a high potential effectiveness for meeting a low arsenic standard, and involve reasonable costs to install and operate. The alternatives that received lower total ratings were limited for the following reasons:

- Activated alumina, which operates optimally at a pH near 6, would consume large amounts of chemical to overcome the high alkalinity of the Fallon groundwater, in addition to adsorption and media losses upon successive regeneration.
- High-pressure membrane separation is highly effective in a single-stage operation, but the high water recovery requirement and consequent need to utilize a multiple-stage configuration (and parallel treatment for concentrate) is a significant limiting factor.
- Granular ferric hydroxide, although potentially the easiest to operate, is a high cost media with a moderately low adsorption capacity.

- POU systems would treat only consumed water, but involve a relatively large amount of complicated record keeping, education, maintenance, monitoring, and frequent system replacement.

Based on the criteria rating results for the most feasible treatment alternatives, SMI recommends that enhanced coagulation and strong-base anion exchange be further evaluated using laboratory-scale tests in a Phase 2 study. The focus of the tests should be to first quantify the effectiveness for As^{5+} removal, then secondly to identify the optimal operation parameters. For enhanced coagulation, the operational parameters would include:

1. Ferric iron dose
2. Operating pH
3. Mixing conditions and flocculant requirement
4. Particulate settling and filtration
5. Operational effects from competing anions
6. Residual characterization.

For strong-base anion exchange, the operational parameters would include:

1. Resin selection
2. Adsorption capacity
3. Empty bed contact times
4. Regeneration conditions
5. Operational effects from competing anions
6. Spent regenerant treatment
7. Residual characterization.

A work plan to perform the laboratory-scale tests, in addition to an estimated budget and schedule, should be prepared. This work plan should define test procedures and conditions, reagent preparation, and the laboratory analyses to be performed. These test parameters should be developed in such a manner that allows appropriate design of pilot-scale testing of the final selected treatment alternative. Pilot-scale testing will provide the essential design parameters for developing a full-scale design.

SMI also recommends that at the conclusion of Phase 2, a detailed comparison of treatment plant capacity and related costs versus dual distribution costs be prepared. The comparison can then be used to determine if it is more cost effective to treat all water and use the existing supply system or to treat a smaller portion of the water and install a dual supply system.

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BENCH-SCALE TEST RESULTS AND FINAL RECOMMENDATION FOR TREATMENT OF ARSENIC IN THE GROUNDWATER SUPPLY OF THE CITY OF FALLON, NEVADA

Prepared for:
City of Fallon

Fallon, Nevada

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January 2001

SHEPHERD MILLER
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1.0 INTRODUCTION

The report presents the results of bench-scale tests that were conducted by Shepherd Miller, Inc. (SMI) to identify the final recommended alternative for treatment of arsenic in the City of Fallon (Fallon) groundwater supply. This work investigated two technologies to determine the feasibility of each for meeting the current (50 micrograms per liter [μg/L]) and proposed (5 μg/L) United States Environmental Protection Agency (EPA) Maximum Contaminant Limit (MCL) for arsenic in drinking water. The two technologies, enhanced coagulation with ferric iron (ECFI) and strong-base anion exchange (SBAE), were identified in an earlier evaluation (*Preliminary Evaluation of Treatment Technologies for Arsenic in the City of Fallon Groundwater Supply*, SMI, 2000). That preliminary investigation considered both conventional and innovative technologies by ranking each alternative using applicable evaluation criteria.

The goal of the bench-scale tests is to define the operational conditions and relevant limitations of the ECFI and SBAE technologies as they apply to the Fallon groundwater. Defining factors such as chemical demands, residual characterization and management, process unit requirements, and representative operational criteria will assist in the comparison of the two technologies listed. In addition, the results generated will support the development and scope of a work plan to test the final recommended alternative in pilot-scale tests.

The results provided in this report are essentially based on batch testing of specific aspects of each technology, except for the flow-through tests to determine the SBAE resin capacity. This method is justified by the intent of the test work, and by the fact that chemical kinetics play a lesser role in the feasibility of the technologies evaluated. If strong dissimilarities exist between the batch tests and a continuous-flow process, the results are prefaced within the context of the conclusions.

For estimating purposes, scale-up comparisons are assumed to be linear for both technologies. Cost estimates are presented exclusively as they relate to material and reagent consumption because (1) only these can be meaningfully calculated in the scope of these tests, and (2) additional operating and capital costs are more accurately described after pilot-scale tests have clearly defined these items.

2.0 TEST PROCEDURES

To effectively generate reliable test results at low arsenic concentrations, certain laboratory test procedures were consistently employed. These procedures are described as follows:

- Test water (Fallon groundwater) was stored in a controlled environment at 22 °C under pressure of high-purity argon gas. Several containers of native groundwater were utilized during the 4-week period that these tests were conducted. Transfer of water between storage containers was performed under pressure of the argon gas to minimize contact with air. Groundwater was frequently monitored for pH and electrical conductivity to confirm chemical stability.

- All glass and plastic equipment used in batch testing was cleaned and acid washed using 0.1 Molar (M) nitric acid (HNO_3), tripled-rinse with deionized (DI) water, then triple-rinsed with an aliquot of test solution prior to contacting the sample solution.

- Batch testing and sample collections were protected from atmospheric contaminants by covering containers with wax film. Latex gloves were worn at all times when handling containers in contact with sample water.

- Analytical sampling was conducted by rinsing pre-cleaned sampling equipment with an aliquot of sample, filtering into pre-labeled bottles with pre-rinsed filters, preserving with analytical grade HNO_3 (0.1 milliliters [mL] per 100 mL sample), and refrigeration at 4 °C.

- Samples were priority shipped overnight to the analytical laboratory within 48 hours of collection, then analyzed within 48 hours of receipt. In many cases, arsenic analyses were performed within 48 hours of sample collection.

- All samples were analyzed by SVL Analytical (Kellogg, ID). Arsenic, iron, and total suspended solids were analyzed using EPA methods 206.2, 200.7, and 160.2, respectively. Because of the low arsenic MCL, a very low detection limit of 1 μg/L was used for arsenic. Quality assurance analyses were performed for each batch of samples analyzed.

3.0 ENHANCED COAGULATION WITH FERRIC IRON (ECFI)

For the City of Fallon groundwater, the effectiveness of the enhanced coagulation process for treatment of dissolved arsenic is primarily dependent on operating pH and the significance of competing anions for adsorption sites. In the bench-scale tests, these two parameters were altered in batch solutions to identify the conditions under which arsenic is most cost-effectively removed. In addition, preliminary testing of particulate settling and size fractionation of coagulated particles were performed to provide an initial indication of clarification and filtration requirements. The complete testing and assessment of particulate separation, an important aspect to developing a complete treatment process for enhanced coagulation, is more suited to continuous flow conditions.

3.1 Effect of Ferric Iron Dose on pH and on Residual Arsenic Concentration

The hydrolysis of ferric iron releases protons into solution, causing a decrease in pH. For the Fallon groundwater, this release of acidity is balanced by the buffering effects of alkalinity (present as bicarbonate and carbonate), causing the excess acidity to be neutralized. This is an important condition to evaluate because the starting pH of the Fallon groundwater supply is above 9, making it less than ideal for enhanced coagulation with ferric iron. The adsorption capacity of arsenic onto ferric hydroxide generally increases as the solution pH approaches the 6 to 7 range. Therefore, the efficiency of arsenic removal without pre-acidification of the native groundwater would be increased with increases doses of ferric iron and subsequent decreases in pH. This effect was tested on a preliminary level for comparison to subsequent tests in which variable iron doses were combined with pre-neutralization.

3.1.1 Test Method

The effect of the ferric iron dose on pH and dissolved arsenic was measured by generating a titration curve that compares various iron doses to pH. To do this, a 0.10-M stock solution of ferric chloride (made up using analytical-grade $FeCl_3 \cdot 6H_2O$; formula weight = 270.30) was added in increments to a 1.00-liter (L) aliquot of Fallon groundwater. The iron additions ranged from 0.5 to 50.0 milligrams per liter (mg/L). Stock iron solution was added using a 10-mL

burette graduated to 0.05 mL. After each incremental addition of ferric chloride solution, pH measurements were made using a calibrated pH meter. Readings were recorded approximately 5 minutes after each addition to allow the solution chemistry to equilibrate. The test was performed under continuous stirring of the groundwater and ferric coagulant solution. A test control was performed in a parallel container with no iron addition to measure the potential effect of carbon dioxide gas dissolution and resultant pH alteration during mixing. The results are shown on Figure 1.

To measure the effect of the ferric iron dose on removal of dissolved arsenic, several concentrations of iron were also added in separate batch tests to aliquots of native Fallon groundwater. These concentrations corresponded to representative doses within the range of concentrations used to generate the titration pH curve. The representative iron concentrations were estimated to meet the requirements for reducing arsenic concentrations to the current 50 μg/L and proposed 5 μg/L standards. These comprised progressively increasing ferric iron dosages of 0.5, 2.0, 5.0, 15.0, 30.0, and 50.0 mg/L. Stock iron solution was added using a 10-mL burette graduated to 0.05 mL. The highest concentration doses, 30.0 and 50.0 mg/L, were included to ensure that treatment to the 5 μg/L arsenic concentration was achieved.

The batch arsenic removal tests were conducted by dosing ferric iron into 1.00-liter aliquots of Fallon groundwater using a stock solution of ferric chloride (0.10 M solution for concentrations above 5 mg/L, and 0.01 M solution for 0.5, 2.0, and 5.0 mg/L) prepared from analytical-grade chemicals and DI water. Solutions were mixed in a sequence of variable speeds to simulate typical velocity gradients that correspond to rapid mixing (5 minutes) and flocculation (20 minutes). After the mixing sequence of each solution was complete, particulates were allowed to settle overnight prior to sampling. Sampling, filtration (with 0.2 micron (μm) pore-size filters), and preservation (with analytical-grade nitric acid) were conducted after the settling period. Filtration with 0.2 μm pore-size filters was selected to simulate membrane microfiltration of the iron-treated solution.

3.1.2 Test Results

Shown in Table 1 are the results for the tests to measure the effect of ferric iron dose on pH and residual arsenic concentration. The data are presented in parallel form to correlate the residual dissolved arsenic concentrations from batch tests to pH values derived from the ferric iron titration curve. These data are also summarized on Figure 1.

Table 1 Results of Initial Ferric Iron Titration and Batch Tests

Iron Dose (mg/L)	mL of 0.1 M Stock Iron Solution Added	Equilibrium pH	mL of Stock Iron Solution Added to Batch	Equilibrium pH	Dissolved Arsenic Concentration (µg/L)
0.0	0	9.09	0	9.11	130[1]
0.5	---	---	0.9 mL 0.01 M	8.99	111
2.0	0.35 mL	8.97	3.5 mL 0.01 M	8.93	98
5.0	0.9 mL	8.74	9.0 mL 0.01 M	8.72	86
10.0	1.8 mL	7.99	---	---	---
15.0	2.7 mL	7.39	2.7 mL 0.1 M	7.44	1
20.0	3.6 mL	7.10	---	---	---
25.0	4.5 mL	6.91	---	---	---
30.0	5.4 mL	6.76	5.4 mL 0.1 M	6.77	<0.7
35.0	6.3 mL	6.63	---	---	---
40.0	7.2 mL	6.49	---	---	---
45.0	8.1 mL	6.37	---	---	---
50.0	9.0 mL	6.28	9.0 mL 0.1 M	6.31	<0.7

1 = Initial arsenic value is based on analytical result for control sample with 0 mg/L iron.

The most notable observation from inspection of the data is that a ferric iron dose of at least 15 mg/L is required before a significant drop in residual arsenic concentration is observed. It is also interesting to note that at this concentration dose the pH begins to approach the range (approximately 6 to 7) where arsenic adsorption onto ferric iron is expected to be highest. This is confirmed by the very low concentrations (<0.7 µg/L) of dissolved arsenic at 30 mg/L (pH 6.77) and 50 mg/L (pH 6.31) ferric iron. It is presumed that the significant drop in arsenic concentrations at the 15 mg/L ferric iron dose (pH 7.44) is due to the increasingly positive surface of the iron hydroxide adsorbent with decreasing pH.

3.1.2.1 Acid/Base Chemistry and Iron Dose

Assuming complete hydrolysis of ferric iron, a 10 mg/L dose of iron is equivalent to adding 0.53 milliequivalents per liter (meq/L) of acid (H^+). The dissociation constants for the carbonate system show that conversion of carbonate to bicarbonate would be nearly complete (99%) at a pH of approximately 8.3. With the carbonate alkalinity of the groundwater being approximately 43 mg/L (as CaCO3), an acid dose of 0.43 meq would be required to reduce the pH of the groundwater from 9.1 to 8.3, approximately corresponding to theoretical acid release by 8 mg/L ferric iron.

Furthermore, a reduction to an approximate pH of 6.3 would require an additional 2.0 meq of acid. This is estimated from the initial bicarbonate alkalinity of the groundwater, the calculated additional bicarbonate generated from protonation of carbonate to pH 8.3, and because at pH 6.3 approximately half of the total bicarbonate concentration is consumed by acidity. This amount of acid (2.0 meq/L) approximately corresponds to an additional 39 mg/L ferric iron. Thus, assuming that the only acid-base reactants are ferric iron and carbonate species, a total of 47 mg/L of ferric iron would theoretically be required to drop the groundwater pH from 9.1 to 6.3. The titration data, which show that 50 mg/L ferric iron corresponds to a pH of 6.28, agrees with these estimates. Therefore, to reach an initial pH in the range of 7 to 8, an acid dose of 0.53 to 1.06 meq/L was estimated to be required. Acid additions in subsequent coagulation tests (described below) are based on these results.

3.2 The Combined Effect of Ferric Iron Dose and pH adjustment on Residual Arsenic Concentration

For the reasons discussed above, reducing the groundwater pH from approximately 9.1 to a more neutral value prior to coagulation with ferric iron is expected to optimize arsenic removal. It is anticipated that the level of residual arsenic concentration for a specific iron dose would be improved for each increase in acid addition. Although pH adjustment can be performed using either hydrochloric acid (HCl) or sulfuric acid (H_2SO_4), sulfuric acid was used in these tests

because it represents a more cost-effective method for pH adjustment. The amount of acid utilized in this test was determined from the ferric iron titration curve (Figure 1).

3.2.1 Test Method

The tests described in Section 3.1.1 were repeated in conjunction with two different acid doses to measure the effect of an initial pH adjustment. The two acid doses were chosen to be 0.53 and 1.06 meq/L for three reasons: (1) these approximately correspond to acidity releases from 10 and 20 mg/L ferric iron doses, (2) these would produce effluent pH values that fall in the range of 7 to 8 for the range of iron doses to be tested, and (3) these equate to 2.0 and 4.0 meq of acid per gallon of water, simplifying unit calculations. Sulfuric acid was added from a 0.50-L batch of 0.53-normal (N) solution made by mixing 7.35 mL of concentrated acid (36 N) with DI water. Pre-neutralization was thus accomplished by 1.00 milliliter per liter (mL/L) (0.53 meq/L) and 2.00 mL/L (1.06 meq/L) doses.

Like the preliminary batch tests described above, this test was also performed by dosing ferric iron into 1.00-L aliquots of pretreated (with H_2SO_4) Fallon groundwater using the same 0.1 M stock solution of ferric chloride prepared from analytical-grade chemicals and DI water. Using a 15 mg/L ferric iron dose as an approximate upper limit to achieve adequate arsenic removal, concentrations of 2.0, 6.0, 10.0, 14.0, and 18.0 mg/L ferric iron for each acid dose were used to evaluate the influence of pre-neutralization on removal of arsenic. These dosage intervals were chosen because it was desired to estimate required ferric iron doses to the nearest 2 mg/L. A parallel test using the indicated ferric iron dosages was performed without acid addition to provide a baseline comparison to the pre-neutralization results.

Prior to addition of iron, pH measurements were made to determine initial conditions. Solutions were mixed in a sequence of variable speeds to simulate typical velocity gradients and detention times that correspond to rapid mixing (5 minutes) and flocculation (20 minutes). After the mixing sequence of each solution was complete, particles were allowed to settle overnight prior to sampling. Post-treatment pH values were measured after this extended settling period. Sampling, filtration (with 0.2 μm pore-size filters), and preservation (with analytical-grade nitric

acid) were conducted after the settling period. Filtration with 0.2 μm pore-size filters was selected to simulate microfiltration of the iron-treated solution.

3.2.2 Test Results

The results for the tests to measure the effect of ferric iron dose and initial pH adjustment on residual arsenic concentration are shown in Table 2. The table shows pH and arsenic values corresponding to the five different ferric iron doses for the 0, 0.53, and 1.06 meq/L acid tests. Figure 2 is a graphical representation of these data that provides a clear comparison of pre-neutralization effects.

Table 2 Effect of Pre-Neutralization on Residual Arsenic Concentrations at Various Ferric Iron Dosages

Ferric Iron Dose (mg/L)	0	2.0	6.0	10.0	14.0	18.0
pH – 0 meq/L Acid	9.11	9.04	8.71	8.06	7.65	7.46
Dissolved Arsenic (μg/L) – 0 meq/L Acid	100[1]	96	67	19	6	2
pH – 0.53 meq/L Acid	8.00	8.01	7.71	7.40	7.25	7.03
Dissolved Arsenic (μg/L) – 0.53 meq/L Acid	100[1]	60	16	4	2	<1
pH – 1.06 meq/L Acid	7.25	7.18	7.06	6.96	6.84	6.76
Dissolved Arsenic (μg/L) – 1.06 meq/L Acid	100[1]	34	4	<1	<1	<1

1 = Initial arsenic value averaged from multiple analyses of groundwater during SBAE testing.

For each of the pre-neutralization conditions, including the no-acid condition, the arsenic objective of 5 μg/L was attained. This level was met for the 0, 0.53, and 1.06 meq/L conditions at approximately 16, 10, and 6 mg/L ferric iron, respectively. The data clearly show that lower arsenic concentrations can be attained for the same ferric iron dose when the acid addition increases. For example, a 6 mg/L ferric iron dose resulted in a residual arsenic concentration of 67 μg/L with no acid, 16 μg/L with 0.53 meq/L acid, and 4 μg/L with 1.06 meq/L acid. Dissolved arsenic was below the detection limit of 1 μg/L for the 18 mg/L ferric iron dose with 0.53 meq/L acid, and for the 10 mg/L ferric iron dose with 1.06 meq/L acid. The pH of the solutions in which arsenic was below detection was approximately 7. With the 1.06 meq/L acid dose, these data suggest that the current 50 μg/L MCL can be met for the Fallon groundwater supply with a ferric iron dose of 2 mg/L or less.

Using the following approximate bulk unit costs for concentrated ($1.25/concentrated gallon; 18 M) and ferric chloride hexahydrite ($FeCl_3 \cdot 6H_2O$; $0.20 per dry pound), a chemical cost analysis was performed for the various treatment conditions given in Table 2. This analysis indicates that the most cost-effective treatment conditions for the current and proposed arsenic standard are those that utilize pre-neutralization. The primary reasons for pre-neutralization cost-effectiveness is the lower cost of H_2SO_4 relative to ferric iron reagent, and the significant increase in arsenic adsorption density on ferric iron at the decreased pH values.

Using the bench-scale testing results, the condition that is most cost-effective for the current 50 μg/L MCL is the 0.53 meq/L acid, 4 mg/L ferric iron dose ($0.05/1,000 gallons). (Note: the iron dose was estimated from Figure 2.) Also using the bench-scale testing results, the most cost-effective condition for the proposed 5 μg/L arsenic MCL, is the 1.06 meq/L acid, 6 mg/L ferric iron dose ($0.09/1,000 gallons). Because these costs are based on bench-scale (laboratory) work, it is possible that the iron and/or acid dosage may need to be increased slightly due to minor losses in adsorption capacity under continuos-flow conditions.

3.3 Effect of Settling Time and Size Partitioning of Coagulated Particles on Residual Iron and Arsenic Concentrations

An essential aspect of the enhanced coagulation process is the separation of solids from the treatment stream, requiring a balance of mixing, clarification, and filtration steps. Mixing dictates particulate size by the amount of energy and time provided for particulate agglomeration. For particulates having the same chemical and electro-potential characteristics, increasing size translates to faster settling rates. Clarification affects particulate separation by providing sufficient detention time to settle and accumulate solids in a central location. Filtration is the final step in particulate separation, removing all remaining suspended and colloidal material. For the Fallon groundwater, the type of filter material utilized would largely depend on the particulate size. Therefore, a preliminary determination of size partitioning and residual arsenic for each particulate size range is helpful in identifying the type of filter material required to meet the treatment objectives.

3.3.1 Test Method

Into two 1.2-L aliquots of neutralized groundwater (with 1.06 meq/L H_2SO_4), 6 mg/L ferric iron was added and mixed using the same method presented in Section 3.1.1. After the mixing sequence was complete, a settling period of 20 and 60 minutes each were followed by decanting of the top 700 mL of solution from the mixture. A portion of the solutions both preserved and unpreserved were submitted to SVL for analysis of iron, arsenic, and total suspended solids (TSS).

Successive filtration of the remaining decanted volume was performed using 1.2 μm, 0.45 μm, and 0.2 μm pore-size filters. Filter sizes were selected to represent both the lower size limit of granular media filtration (1.2 μm) and typical pore sizes of microfiltration membranes (0.45 and 0.2 μm). After each filtration, samples were collected for analysis of iron and arsenic.

TSS measurements were only performed for samples obtained before and after the 1.2 μm filtration, because all TSS measurements after the 1.2 μm filtration were below the method detection limit. For each of the settling times, two samples were submitted to the laboratory for measurement of TSS. The first sample was filtered by SMI using a 1.2 μm filter, and the second sample was unfiltered. The laboratory then analyzed both samples using 0.2 μm filters which is a modification of the typical analysis method for TSS (gravimetric, using 1.2 μm filtration). Because the results of the analysis of the SMI filtered samples (1.2 μm) were below detection, the results of the analysis of the unfiltered samples were the values used for ">1.2 μm."

3.3.2 Test Results

Shown in Table 3 are the results of the particulate settling and partitioning test. The metals concentrations are combined dissolved and total analyses because they represent filtered samples (at various pore sizes) that were preserved with nitric acid. Although TSS measurements were made for only the largest two size fractions, the smaller size fractions have been estimated based on the "<1.2" results (as less than the detection limit). These data are also shown on Figure 3.

Table 3 Dissolved Metal Concentrations and TSS for Settling and Size Partitioning Tests

Size Range	20 Minute Settling			60 Minute Settling		
	Fe (mg/L)	As (mg/L)	TSS (mg/L)	Fe (mg/L)	As (mg/L)	TSS
>1.2	4.48	0.074	8.3	2.14	0.044	3.8
<1.2	0.09	0.006	<0.1	0.04	0.006	<0.1
<0.45	0.05	0.005	<0.1[1]	<0.02	0.005	<0.1[1]
<0.2	0.04	0.004	<0.1[1]	<0.02	0.004	<0.1[1]

1 = TSS concentrations for this size range are estimated below detection based on "<1.2" results.

Both the settling time and effective filter size appear to have a significant effect on residual iron, arsenic, and TSS concentrations. In the unfiltered solutions, increasing the settling time from 20 minutes to 60 minutes reduced the TSS concentrations by 54 percent to 3.8 mg/L. The residual arsenic concentration for each of these solutions was approximately 1.7 to 2.1 percent of the residual iron concentration. Residual arsenic concentrations for both settling times (prior to filtration) exceeded the 5 μg/L objective, while the 50 μg/L MCL was met for the 60-minute settling time (0.044 mg/L).

For both settling times, coarse filtration of the batch-test supernatant (1.2 μm) caused a decrease in residual iron concentration of 98 percent, and reduced arsenic concentrations to 6 μg/L. Successive filtration at a pore size of 0.45 and 0.2 μm, reduced arsenic concentrations to 5 and 4 μg/L, respectively, for both settling times. As shown on Figure 3 and in Table 3, residual iron concentrations were slightly greater at the smaller filter pore sizes for the shorter settling time (0.04-0.05 mg/L versus <0.02 mg/L); but the residual arsenic concentrations are identical for both times, which suggests that residual arsenic is largely unassociated with iron at these particulate sizes. Taken in light of the fact that the final residual arsenic concentrations agree with the corresponding batch tests results for a 6 mg/L iron dose, it is possible therefore that a larger pore size filter (such as a granular media), used in conjunction with a slightly higher coagulant dose, may be effective for meeting the 5 μg/L arsenic objective. A primary consideration of this type of process would be the effect of a higher residual iron concentration in the final treated effluent, particularly if shorter settling times are employed. The alternative is to

optimize the ferric iron dose and rely on a smaller pore size membrane filtration process. These test data clearly indicate the potential for both granular media and membrane filtration for pilot-scale testing.

3.4 Toxicity Characteristic Leaching Procedures (TCLP) Testing for Arsenic on Representative Sludge Samples

A primary consideration for the enhanced coagulation process is the chemical characteristic of the residuals that would be generated in the treatment process. At 2,500 gallons per minute (gpm) and 10 mg/L iron, the total mass of sludge generated (assuming 20 percent by weight) might exceed 500 tons per year. Disposal of this mass of sludge in a regulated facility for hazardous wastes would be a significant operating expense, thus making it an important management aspect of the enhanced coagulation process to understand.

3.4.1 Test Method

To measure this parameter, representative sludge samples were generated for approximate test conditions that meet the 5 μg/L arsenic standard. To generate an adequate mass of solid residual, a 190-L volume of untreated groundwater was simultaneously dosed with 1.52 grams of ferric iron and 0.40 equivalents of H_2SO_4; these amounts correlate to 8.0 mg/L ferric iron and 1.06 meq/L H_2SO_4 doses. Although a 6 mg/L ferric iron dose was earlier identified as sufficient for meeting the proposed lower arsenic MCL, it is likely that under continuous-flow conditions there would be a minor loss in adsorption efficiency and that a slightly higher dose (e.g., 8 mg/L) may be required. These conditions were chosen for the following reasons: (1) they approximate cost-effective operational conditions that correspond to an arsenic adsorption density on iron of 12.5 μg Arsenic per 1.0 mg iron, and (2) an 8 mg/L ferric dose generated an adequate mass of sludge for TCLP testing.

After stirring the batch sample for 90 minutes, the precipitated iron was allowed to settle overnight. The clarified water was then decanted while the settled solids were filtered through 1.2 μm pore-size filters under a gage vacuum pressure of 23 pounds-per-square-inch. A fresh sludge sample (20 percent solids by weight) was collected, extracted, and analyzed for arsenic (by SVL Analytical) using EPA TCLP Test Method 1311. A second sludge sample (21 percent solids by weight) was allowed to air dry (at room temperature) for 7 days before TCLP testing.

The second sludge sample provides an initial indication of how aging the solid residual for a short period would affect its chemical stability, and whether additional sludge processing would need to be considered.

3.4.2 Test Results

TCLP extract results for arsenic indicate that both fresh and dried sludge yield low arsenic concentrations. The extract from the fresh sludge sample (4.1 grams at 20 percent solids by weight) contained 0.05 mg/L arsenic, while the air-dried sludge sample (1.4 grams) extract contained less than 0.01 mg/L arsenic. Both extract arsenic concentrations fall well below the current TCLP regulated limit of 5.0 mg/L, indicating that management of sludge from the enhanced coagulation process would not require handling and disposal as a hazardous substance. Although drying of the sludge produced in this process represents a simple method for stabilizing the material, the very low extract arsenic concentration (relative to the 5.0 mg/L limit) from the fresh sludge strongly suggests that direct disposal of this process residual would be possible.

4.0 ANIONIC EXCHANGE WITH CONVENTIONAL STRONG-BASE RESINS

The strong-base anion exchange process consists of a sequence of cycles that first removes then concentrates arsenic into a small waste stream. This type of process includes four cycles that are repeated under the same operating conditions: (1) the service (or exhaustion) cycle in which arsenic is adsorbed to the resin, (2) the backwash cycle in which the resin is expanded, reoriented, and rinsed of particulate material, (3) the regeneration cycle in which the arsenic is removed from the resin and exchange sites are refreshed, and (4) the rinse cycle to remove residual regenerant solution before the next service cycle. During bench-scale testing, the four process cycles were repeated for five service cycles using resins obtained from three different manufacturers (a total of 15 complete cycles).

Table 4 Description and Test Conditions for Strong-Base Anionic Exchange Resins

Characteristic	Resin 1	Resin 2	Resin 3
Matrix Structure	Styrene-DVB Gel	Acrylic Gel	Styrene-DVB Gel
Functional Group	Amine	Amine	Amine
Type	1	1	2
Shipping Density (g/L)	670	720	700
Approx. Wet Swelling (percent)	20	20	10 - 15
Exchange Capacity (meq/mL)	1.3	1.25	1.45
EBCT[1] (minutes)	2	2	2
Regenerant Strength (M)	1.0	0.50	1.0

1 = Empty bed contact time.

Slight operational variations were applied to each resin to assess the most significant aspects of this process. Although operational parameters beyond those investigated in these tests would be assessed during pilot-scale design, the described tests are sufficient to understand the feasibility, potential limitations, and operational costs of this technology.

4.1 Resin Capacity and Arsenic Leakage During Exhaustion

Measuring the resin capacity for arsenic provides an indication of the operational requirements for this technology. Resins that are quickly exhausted after a limited number of treatment bed volumes would require more frequent regeneration, and possibly replacement. Quantifying the number of bed volumes that a particular resin can effectively remove a target constituent before

exhaustion is an essential parameter to determine for pilot- and full-scale applications. For the Fallon groundwater, the primary factors that would affect resin capacity are the concentrations of competing anions (primarily sulfate, nitrate, and carbonate) and regeneration efficiency.

4.1.1 Test Method

The test to determine resin capacity and arsenic leakage was performed using three continuous-flow columns that each contain a 50-mL sample of the resins presented in Table 3. Columns were constructed of clear, schedule-40 PVC pipe having an inside diameter of 0.5 inches and a total length of 24 inches. Groundwater was passed through the resin beds in a vertical, down-flow mode using precision-controlled peristaltic pumps. Test flow rates were identical for all columns (two empty bed volumes/minute) and were determined by recommended manufacturer specifications. Effluent water from the columns was collected in reservoirs (having volumetric gradations) to measure treated bed volumes (BVs) and to confirm test flow rates.

Column effluent samples for initial runs were collected at intervals of 100 BVs (up to 500) to preliminarily determine the capacity for arsenic of each resin. After resin capacities were approximated, samples were collected at intervals of 25 BVs in the approximated range to more precisely determine the capacities over the next two exhaustion runs. Although particulate material was not anticipated to be present in the column effluents, collected samples were filtered (and preserved with nitric acid) prior to analysis for arsenic to ensure that fine resin particles were removed. All samples sent in for laboratory analysis were first analyzed for pH and conductivity upon collection, while samples collected during the first two exhaustion runs were also analyzed for sulfate (using a portable colorimeter).

4.1.2 Test Results

Table 5 summarizes operating data for the three SBAE resins that were bench-scale tested in the SMI laboratory. Shown in Table 5 are the estimated BVs to breakthrough (defined by an effluent arsenic $\geq$5 μg/L). The arsenic leakage column consists of arsenic concentrations in the column effluents prior to breakthrough. The arsenic concentrations are averaged values consisting of both detected and non-detected concentrations. For dissolved arsenic concentrations below detection, average concentrations were calculated using a value equal to

half the detection limit. The range of values representing BV's to breakthrough varies depending on the frequency of sampling and analysis for effluent arsenic concentrations. Sampling frequencies for column effluents were 50 to 100 BVs for runs 1 and 2, 25 BVs for runs 3 and 4, and 50 BVs for run 5. For runs 3 and 4, the sampling frequencies were increased to provide a more definite measurement of column breakthrough for arsenic. Sampling frequencies for run 5 were chosen simply to monitor the resin capacity for arsenic after pre-neutralization of the influent.

Table 5 Test Operating Data for Three SBAE Resins

Run	Resin 1		Resin 2		Resin 3	
	No. of Bed Volumes[1]	Arsenic Leakage µg/L[2]	No. of Bed Volumes	Arsenic Leakage µg/L[2]	No. of Bed Volumes	Arsenic Leakage µg/L[2]
1	200 – 300	<0.7	200 – 300	<0.7	300 – 400	0.9
2	300	<0.7	200 - 300	<0.7	300 – 350	1.85
3	275 – 300	1.25	275 – 300	<1	325	2.33
4	275 – 300	3.5	250 – 275	3	275 – 300	2
5	250 – 300	0.7	---	---	450 – 500	1.4[3]

1 = To breakthrough (i.e., ≥5 µg/L).
2 = Averaged concentrations include below detection limit data that are approximated at half the limit.
3 = Influent was neutralized prior to testing the resin capacity.

For the SBAE resins tested, the average exchange capacities for arsenic ranged from approximately 250 BVs (resin 2) to 305 BVs (resin 3), with resin 1 having an intermediate capacity of 280 BVs. With the exception of run 3 for resin 3, these capacities were calculated using a simple linear interpolation through the 5 µg/L arsenic concentration for all test runs. On run 3 for resin 3, the breakthrough value of 5 µg/L was measured at 325 BVs. Based on previously reported data for waters having similar sulfate concentrations to the Fallon groundwater and the capacity ratings for the particular resins tested, these exchange capacities are significantly lower than expected. The elevated pH and high alkalinity of the Fallon groundwater are presumed to be the reason for these unexpected results. Analysis of the groundwater indicates relatively high concentrations of dissolved carbonate (CO_3^{2-}), which is an anion that competes with arsenic for the exchange sites of the resins. Further discussion and test work to confirm this hypothesis are described in Section 4.4.

Average arsenic leakage (prior to breakthrough) in the column effluents was substantially below the 5 μg/L level, although a general increasing trend was observed in all columns for runs 1 through 4. After each run, the exhausted resin was regenerated as discussed in Section 4.0. A potential cause of this increasing trend is incomplete regeneration of the resin (with respect to arsenic) between the runs. Incomplete regeneration can be related to the method of regeneration or minor losses in capacity due to irreversible exchange reactions. Although the data for these initial test runs of SBAE resin suggest that arsenic leakage may be a factor in prolonged operation, run 5 data indicate that this factor not as significant as inadequate exchange capacity. In run 5 (pre-neutralization of influent water), arsenic leakage was observed to decrease for resins 1 and 3, while the exchange capacity of resin 3 increased significantly.

4.2 Effect of Varying Regenerant Strength on Regeneration Efficiency

Measuring the efficiency of regeneration is important in ion exchange because it directly influences the operational feasibility and cost of the process. The test resins were run in the chloride form and therefore regeneration of exhausted resin was accomplished using concentrated sodium chloride (NaCl) solutions made from analytical-grade chemicals and treated column effluent. Different molar concentrations of NaCl solution were tested on resins 2 and 3 to measure the effect of varying regenerant strength on regeneration efficiency.

4.2.1 Test Method

After arsenic breakthrough, regeneration of the exhausted resin was accomplished using different strengths of fresh regenerate, prior to the next run. As shown on Table 4, the regenerant strengths selected were 0.5 M (7.3 grams in 250 mL) and 1.0 M (14.6 grams in 250 mL) NaCl solutions for resins 2 and 3, respectively. The method of regeneration had the following sequence of steps: (1) backwash with influent groundwater in countercurrent flow for 10 minutes at 15 mL/min then drain, (2) regeneration of the exhausted resin with 5 BVs of fresh regenerant solution in concurrent flow for 80 minutes at approximately 3 mL/min then drain resin, and (3) a displacement rinse of the regenerated resin with 10 BVs at 5 mL/min for 100 minutes. In addition to monitoring run lengths to breakthrough, arsenic concentrations were measured in the first displacement rinse solutions and at the beginning of each run (first 10 BV's) to measure the effects of different regeneration conditions on initial arsenic leakage.

4.2.2 Test Results

Shown in Table 6 is a comparison of resin 2 and resin 3 results for four exhaustion runs using two different strength regenerant solutions. Resin 2 was regenerated using a fresh batch of 0.5 M NaCl solution after each exhaustion run, and resin 3 was regenerated using a fresh batch of 1.0 M NaCl solution. A fifth exhaustion run was conducted with resin 3, but is not shown because the conditions of the test were modified to measure the effect of pre-neutralization of the influent solution.

Table 6 Comparison of Test Operating Data for Four Exhaustion Runs Using Two Different Resins and Regenerant Strengths

Run	Approximate Bed Volumes[1]		Average Arsenic Leakage	
	Resin 2 (0.5 M NaCl)	Resin 3 (1.0 M NaCl)	Resin 2 (0.5 M NaCl)	Resin 3 (1.0 M NaCl)
1	200 – 300 (240)	300 – 400 (300)	<0.7	0.9
2	200 – 300 (235)	300 – 350 (305)	<0.7	1.85
3	275 – 300 (280)	325 (325)	<1	2.33
4	250 – 275 (250)	275 – 300 (285)	3	2

1 = Numbers in parentheses indicate interpolated values through the 5 μg/L breakthrough concentration.

Using bed volumes to breakthrough (5 μg/L) as an indicator, both resins display an overall increase in exchange capacity from run 1 to 3. However, a drop in the number of bed volumes to breakthrough is observed for both resins from run 3 to 4, suggesting that the available bed volume data are not sufficient to make a definitive determination. As shown on Figure 5, the effluent pH values for exhaustion runs of resin 2 show a trend of increasing pH values for each successive run, suggesting that this resin may be losing capacity for arsenic and that its effective life may be compromised by using a lower strength regeneration solution. This same trend is not observed for resin 3 (Figure 6), in which a higher strength solution was utilized. The data presented in Figure 7, show that increasing pH values correlate closely to increasing arsenic leakage. Therefore, based on this data, effluent pH values can provide an indicator of breakthrough. It should also be noted, that while these resins are similar and made by the same manufacturer, they are not identical. Although the available information from four exhaustion runs does not provide conclusive evidence that a higher strength regenerant solution is more effective, it does seem to indicate (on the basis of pH) that a higher strength regenerant may be more suited for the City of Fallon groundwater.

4.3 Effect of Repeated Use of Regenerant Solution

Repeated use of regenerant decreases both the volume of water wasted by the process as well as the amount of spent regenerant requiring treatment. If a regenerant solution can be replenished to initial molar strengths after each regeneration and not diminish the resin capacity for a large number of runs, not only would the volume of water wasted be minimized but the required size of spent regenerant treatment units would be smaller. The test method and results are described in the following sections.

4.3.1 Test Method

For resin 1, the same regenerant solution, after replenishment to an initial chloride level, was repeatedly used after successive exhaustion runs. The replenishment level was determined to be 3.8 g of NaCl, based on a theoretical exhaustion capacity assumed to be equivalent to the exchange capacity of 1.3 meq/mL for 50 mL of resin. To test the effect of repeated use, a total of five exhaustion runs and four regenerations of resin 1 were performed using the same 250 mL batch of concentrated 1.0 M NaCl regenerant.

4.3.2 Test Results

The test data for five exhaustion runs using resin 1 and the same regenerant solution are shown in Table 7. As in previous tests, the number of bed volumes to breakthrough has been estimated as a range and by interpolation of data through the breakthrough concentration. The arsenic leakage data include some below detection limit values that were approximated at half the detection limit, except for runs 1 and 2 in which all values were less than detection.

Table 7 Test Operating Data for Five Exhaustion Runs of Resin 1 After Repeated Use of Regenerant Solution

Run	Approximate Bed Volumes[1]	Average Arsenic Leakage (µg/L)
1	200 – 300 (260)	<0.7
2	300 (300)	<0.7
3	275 – 300 (290)	1.25
4	275 – 300 (285)	3.5
5	275 – 300 (270)	0.7

1 = Numbers in parentheses indicate extrapolated values through the 5 µg/L breakthrough concentration.

On the basis of both breakthrough and arsenic leakage data (Table 7), repeated use of a replenished regenerant solution appears to have a slight effect on the capacity of an SBAE resin. This result is similar to results for the non-replenished regenerant solution for resin 3, discussed in Section 4.2. If the increase in capacity from run 1 to run 2 is not considered (because the initial regeneration occurs between these runs), a drop off in capacity of 10 percent is observed from run 2 to run 5. Also, it appears that average arsenic leakage is increasing from the first two runs through run 4. However, the lower arsenic leakage in run 5 may indicate that this is not a real trend associated with the regenerant solution, but maybe caused by another factor possibly related to the regeneration procedure. The arsenic leakage concentrations are an average of samples taken throughout the sampling run. Because of the procedure used, the effectiveness of the displacement rinse step, of the regeneration procedure, may vary slightly between runs. This variation may influence arsenic concentrations for samples taken early in each run.

If the apparent decrease in resin capacity is real, then the prospect of frequent regeneration (given the relatively low exchange capacity for the City groundwater) becomes a significant factor to consider. Defining the limit of regenerations that can be performed with the same replenished solution would be an important parameter to define for a large-scale system. However, when resin 1 data (Table 7) are compared to resin 3 data (Table 6, decrease in breakthrough bed volumes from 325 to 285, runs 3 and 4) for differences in exchange capacity after successive exhaustion runs, the apparent decrease for resin 1 does not appear as significant. Therefore, based on the available information, that the efficiency of regeneration with a replenished solution (through at least 5 runs) does not appear significantly different than regeneration with a fresh solution of similar strength.

4.4 Effect of Influent Neutralization on Run Length

The presence of preferential anions to arsenate, such as the divalent carbonate and sulfate anion, decreases a resin's capacity for arsenic. In the case of Fallon, in which alkalinity is present (in City Well 4) at an average concentration of 220 mg/L (as $CaCO_3$) and the pH is above 9, the probability of competition for exchange sites by carbonate (CO_3^{2-}) is high; at pH 9.1, carbonate accounts for approximately 0.9 meq/L of the total alkalinity (4.4 meq/L). One possible method for decreasing the effect of carbonate on resin capacity is to neutralize the native groundwater

prior to contacting it with resin. The effect of neutralization is the conversion of carbonate ions to the less competitive (relative to the arsenate oxyanion), monovalent bicarbonate anion (HCO_3^-).

4.4.1 Test Method

For exhaustion run 5, the influent groundwater feeding into resin 3 was neutralized with 1.06 meq/L of HCl. Hydrochloric acid was utilized in this test because the addition of sulfuric acid would increase the influent sulfate concentrations from approximately 1.8 meq/L to more than 2.8 meq/L, causing a further decrease in resin capacity for arsenic. Resin 1 was operated in parallel to resin 3 for this exhaustion run to provide a baseline comparison. The application flow rate and all other test procedures for run 5 were identical to those used in all previous runs.

4.4.2 Test Results

Table 8 presents the results of exhaustion run 5 for resins 1 (no pre-neutralization) and resin 3 (pre-neutralization). Arsenic and alkalinity data were collected to assist in the evaluation of resin capacity for arsenic in the presence of varying concentrations of bicarbonate and carbonate.

Figure 8 compares arsenic leakage from resin 3 for pre-neutralization and no acid conditions. Also shown on this figure are alkalinity data in resin 3 effluent for the pre-neutralization conditions.

Table 8 Arsenic Leakage in Run 5 for Resins 1 and 3

Bed Volume	Resin 1 (no pre-neutralization)		Resin 3 (pre-neutralization)	
	As µg/L	Alkalinity mg/L as $CaCO_3$	As µg/L	Alkalinity mg/L as $CaCO_3$
10	<1	1.3	2	4
100	1	141	<1	103
200	<1	190	<1	186
250	<1	201	<1	197
300	11	205	1	197
350	43	273	1	190
400	nm	---	2	200
450	nm	---	4	201
500	nm	---	11	198

Pre-neutralization of the native groundwater increased the resin capacity (resin 3) for arsenic to approximately 460 bed volumes. When compared to previous test runs for resin 3, this represents an increase in capacity of at least 50 percent. The principal reason for this increase in capacity is believed to be the conversion of carbonate to bicarbonate (by pre-neutralization), a less preferred anion relative to arsenate. Average arsenic leakage during the pre-neutralization run was less than 1 μg/L (after substituting 0.5 μg/L for below detection limit values) for the first 400 bed volumes. The effluent arsenic concentration after 10 bed volumes (2 mg/L) is not considered in this average because it represents eluted arsenic in regenerant solution that was retained by the resin after draining.

Assuming that carbonate is essentially absent in the influent solution, and that no other preferred anions are present, the additional arsenic capacity generated by pre-neutralization is approximately 0.9 meq/L. Because sulfate is the most preferred anion by SBAE resins, and is present at a significant concentration in the Fallon groundwater (1.9 meq/L in City Well 4), sulfate will ultimately dictate resin capacity. Using the additional arsenic capacity generated by pre-neutralization (0.9 meq/L), and the total exchange capacity that would be used by sulfate (1.9 meq/L), an estimated increased capacity of 47 percent is calculated. This increase is in close agreement with the percentage increase (50 percent) observed during run 5 as compared to the average of runs 1 through 4 for resin 3.

The significant decreases in pH and alkalinity early in each sample run suggests that bicarbonate is initially removed by the resins (by deprotonation and exchange of carbonate). However, as each service run continues, the pH increase and stabilization of alkalinity concentrations indicate that exchange of bicarbonate only occurs initially then is eventually eliminated from the resin as the number of available sites becomes depleted. It can therefore be concluded that sulfate and carbonate are the principal competitors for arsenate, and that the effect of other anionic constituents, such as chloride and silicate, is not a significant limiting factor in this application.

4.5 Effect of Ferric Iron Dose on Residual Arsenic in Treated Spent Regenerant

Spent regenerant solution resulting from regeneration of exhausted resin would most likely contain high levels of sodium, sulfate, bicarbonate, and arsenic. Treatment of this concentrated water would be required to reduce arsenic levels prior to disposal. One of the most efficient methods for treatment of this solution is to co-precipitate arsenic onto coagulated ferric hydroxide particles. The goals of this test are to estimate the levels of arsenic reduction that can be achieved for spent regenerant, and to understand the required amount of ferric iron addition. Because arsenic is expected to be highest in resin 1 spent regenerant (due to the repeated use for four regenerations), this regenerant solution was utilized for this test.

4.5.1 Test Method

To remove arsenic from resin 1 spent regenerant solution, ferric iron was dosed into two separate aliquots (100 mL each) at different molar ratios (iron:arsenic). For this test, molar ratios of 10:1 and 20:1 (iron:arsenic) were used for an initial arsenic concentration of 12.7 mg/L in the regenerant solution. This arsenic concentration is approximately half of the amount predicted to be present because exhaustion runs were carried out beyond breakthrough and a large mass of arsenic was lost to the column effluent as concentrations peaked. The calculated ferric iron doses were approximately 95 and 190 mg/L for the two molar ratios. The procedure for treatment was similar to that used in previous tests of ferric iron coagulation (Section 3.0), except that samples were processed using 0.45 μm filters.

4.5.2 Test Results

Residual arsenic concentrations in the treated regenerant solution were high for the molar ratios of iron to arsenic, tested. For the 10:1 molar ratio (95 mg/L ferric iron), the dissolved arsenic decreased from 12.7 to 8.04 mg/L, while it decreased only to 4.16 mg/L for the 20:1 molar ratio (190 mg/L). Depending on the concentrations of other constituents in the treated spent regenerant, a concentration over 4 mg/L would probably be too high for management of this waste stream. In addition, the measured arsenic concentration of 12.7 mg/L is approximately

half of the predicted amount to be present (24 mg/L) because exhaustion runs were carried out past the point of exhaustion, causing a significant proportion of the arsenic to be lost in the column effluent prior to regeneration.

Conservatively assuming that a 30:1 molar ratio dose of ferric iron (540:24 Fe:As, in mg/L) would produce a sufficient reduction in arsenic for disposal, the amount of reagent required would be significant. For a scenario in which a combined solution of spent regenerant and displacement rinse were treated with a 30:1 dose of ferric iron, an amount of coagulation reagent equivalent to almost 40 percent of that used in the enhanced coagulation process (assuming 6 mg/L) would be required. This calculation is made assuming 100 percent recovery of arsenic from the SBAE resin, and by simply comparing the molar ratio for a 6 mg/L ferric iron dose (80:1) and the predicted 30:1 molar dose for spent regenerant treatment.

4.6 Estimated Operational Cost for SBAE

Influent pre-neutralization represents a key step for maximizing the capacity of SBAE resin for arsenate. For purposes of operational cost comparisons, the scenario of pre-neutralization with resin 3 was used as a representative case. The primary operational costs for this process are based on reagents (NaCl, HCl, and $FeCl_3$) and resin replacement. The operational cost for SBAE was estimated based on the following unit costs: (1) $60 per ton for NaCl, (2) $1.10 per gallon for HCl, (3) $0.20 per pound for ferric chloride hexahydrite, and (4) $105 per cubic foot of resin.

Assuming a resin capacity of 450 bed volumes, resin replacement every 300 runs (based on manufacturers literature and Fallon water chemistry), reuse of regenerant at a replenished concentration of 1.0 M NaCl, treatment of 50 mg/L arsenic in spent regenerant after every 10 regenerations (based on work performed by Clifford, 1999, Fallon water chemistry, and the apparent poor treatment results for spent regenerant), a unit cost of $0.27/1,000 gallons is estimated. This figure only considers costs related to items listed and does not include costs related to power, operators, residuals management, etc. This estimated cost is much higher than the estimated costs associated with using enhanced coagulation (Section 3.0).

5.0 SUMMARY OF RESULTS

5.1 Enhanced Coagulation with Ferric Iron

Titration of Fallon groundwater with ferric iron can be approximately described by the acid-base reaction involving metal hydrolysis and bicarbonate/carbonate alkalinity. An 8 mg/L dose of ferric iron is required for conversion of carbonate to bicarbonate in the native groundwater (approximate pH of 8.3), and an additional 42 mg/L is required to reach a pH of 6.3, the point where half of the bicarbonate is converted to carbonic acid. Although it is not necessary to decrease the pH to 6.3 for effective arsenic adsorption onto ferric hydroxide, the data indicate that residual arsenic concentrations are lowest for solutions having pH values below 7.5. The acidity generated by hydrolysis of 10 mg/L ferric iron is calculated to be equal to 0.53 meq/L of acid, and as shown on Table 1, is capable of decreasing the groundwater pH from 9.1 to 8.

Pre-neutralization of Fallon groundwater with sulfuric acid significantly increases arsenic adsorption onto ferric iron. For achieving residual arsenic concentrations (after filtration) that meet the proposed MCL of 5 μg/L, the required ferric iron dose decreases from approximately 15 mg/L with no pre-neutralization to 10 and 6 mg/L for acid doses of 0.53 and 1.06 meq/L, respectively. To meet the 50 μg/L MCL, the required coagulant dose decreases from approximately 8 mg/L (no pre-neutralization) to 4 mg/L with a 0.53 meq/L acid dose. The improved performance and the relatively lower cost of sulfuric acid, at the doses tested, indicate that pre-neutralization would be the most cost-effective method for enhanced coagulation with ferric iron, particularly considering the reduced mass of sludge that would be generated at the lower iron dose. Estimated costs, based on bench-scale work, for pre-neutralization and adsorption of arsenic with ferric iron are $0.05 and $0.09 per thousand gallons in order to reduce arsenic concentrations to less than 50 μg/L and 5 μg/L, respectively.

Settling and size partitioning of coagulation solutions indicate that filtration would be an essential aspect of the enhanced coagulation process. For test conditions in which 1.06 meq/L sulfuric acid and 6 mg/L ferric iron were dosed into native groundwater, the supernatant generated after a 60-minute settling time still contained 44 μg/L arsenic and 2.14 mg/L iron. Coarse filtration (1.2 μm) of the supernatant after 20- and 60-minute settling times reduced iron

concentrations to less than 0.1 mg/L and arsenic to approximately 6 μg/L. Successive filtration at 0.45 and 0.2 μm nominal pore sizes caused further reductions in iron and resulted in a final dissolved arsenic concentration of 4 μg/L. Although the data clearly indicated that for a 6 mg/L ferric iron dose a significant arsenic reduction can be attained at the 1.2 μm filter size, it was also shown that smaller-pore filters (0.2 μm) may be required to meet the 5 μg/L objective. To meet the current arsenic MCL of 50 μg/L, the batch test data indicate that granular media filtration may be sufficient.

Solid residual produced by coagulation with 8 mg/L ferric iron was generated in batch solutions and tested for hazardous characteristics relative to arsenic and found to comply with TCLP extract concentration limits. Both fresh and air-dried sludge were tested, having arsenic extract concentrations of 0.05 and <0.01 mg/L, respectively. These preliminary data indicate that management of sludge from the enhanced coagulation process would not require handling and disposal as a hazardous substance, thus allowing direct disposal of solid residual into a standard class (i.e., non-hazardous) landfill.

5.2 Strong-Base Anionic Exchange Resins

Testing of native groundwater in columns containing three different SBAE resins showed that the resin capacity for arsenic ranges from 250 to 305 empty bed volumes. Based on influent sulfate concentrations, these resin capacities are considered to be approximately half of the expected results. It is believed that the apparent reduction in capacity is related to the presence of high levels of alkalinity (carbonate). Arsenic leakage (through the resins) in the process effluent was substantially low, below the 5 μg/L level, although an increasing trend was observed during bench-scale testing. However, the test run in which influent groundwater was pre-neutralized (run 5) indicates that arsenic leakage is a secondary factor to exchange capacity because arsenic leakage during this run was observed to decrease while treated bed volumes to breakthrough increased.

Regeneration of the SBAE resins using varying regenerant strength solutions suggests that a higher-strength solution (1.0 M NaCl) is better suited than a weaker-strength solution (0.5 M NaCl) for resins used on the Fallon groundwater. Although the preliminary data generated by

these exhaustion runs are not conclusive evidence of a loss in capacity as a result of regeneration with a weaker solution, there is definitely an indication that prolonged use under these conditions would compromise the resin's effective life. This is because arsenic leakage data and progressively increasing pH values (pH is a general indicator of arsenic breakthrough) after regeneration with a 0.5 M NaCl solution suggest that resin capacity may be depleted using the weaker solution.

Repeated use of a replenished (to 1.0 M NaCl) regenerant solution, does not appear to have a significant effect on exchange capacity when compared to regeneration with a fresh solution of the same strength. A decrease in capacity of approximately 5 percent (replenished) and 7 percent (fresh) regenerate treated resins was observed between runs 2 and 4. It is assumed that the number of repeated uses would be limited to between 5 and 10 regenerations before significant losses in exchange capacity (for arsenic) would occur. Therefore, the combined volume of regenerant and displacement rinse (10 BVs) solutions would be approximately 2.3 percent of the treated effluent volume (based on 460 BVs [pre-neutralization] treated per service run); the combined regenerant volume using a 5 BV displacement rinse correlates to approximately 1.2 percent of the treated effluent volume.

Pre-neutralization of the influent groundwater increased the resin capacity for arsenic approximately 50 percent. The average arsenic leakage during the pre-neutralization test was less than 1 μg/L for the first 400 bed volumes treated. The effluent concentrations and operating pH indicate that the primary reason for the increased arsenic exchange capacity is related to the presence of dissolved carbonate in the feed water. The reduction of carbonate anions in contact with the resin results in a potential decrease in demand for exchange sites of 0.9 meq/L. Because this amount is very close to the calculated increase in capacity after pre-neutralization, using a sulfate concentration demand of 1.9 meq/L, it is presumed that these two divalent anions are the principal competitors for arsenate, and the that potential limiting effect of other anionic constituents, (i.e., chloride and silicate), is not significant.

Treatment of the arsenic-laden (12.7 mg/L), spent regenerant from the SBAE process with ferric iron showed that a molar ratio exceeding 20:1 (Fe:As), which was tested, is required for adequate

removal of arsenic. Using the residual concentrations from 10:1 and 20:1 molar dose of ferric iron, a minimum molar ratio dose of 30:1 (22.4 Fe:1 As in mg/L) is predicted to be required. This amount of ferric iron is equivalent to 40 percent of that required by the ECFI process to meet the proposed MCL of 5 μg/L (6 mg/L ferric iron [equivalent to an 80:1 molar ratio dose] and pre-neutralized influent). While this comparison is not completely accurate (i.e., differing pH values and final concentration values) it does indicate that additional (possibly significant) costs will be incurred to treat the spent regenerant to an acceptable concentration, prior to disposal. Even though both processes investigated are assumed to co-precipitate the same total mass of arsenic, the ratio of iron:arsenic (30:1 versus 80:1 for ECFI) is lower for the spent regenerant treatment because its adsorption density is predicted to be higher and because competing ions have been previously removed during treatment.

The estimated operational cost of the SBAE process for reagents and resin replacement is $0.27 per thousand gallons treated, assuming an arsenic treatment level of 5 μg/L. This figure is based on the following: (1) pre-neutralization with 1.06 meq/L HCl, (2) a bed volume capacity before breakthrough of 460, (3) repeated regeneration with the same replenished 1.0 M NaCl solution (up to 10 times), (4) treatment of spent regenerant/displacement rinse solution at a molar ratio of 30:1 (Fe:As), and (5) replacement of resin every 300 exhaustion cycles.

6.0 FINAL RECOMMENDATION FOR PILOT-SCALE TESTING

In bench-scale test work, both technologies are demonstrated to remove arsenic in the Fallon groundwater supply to levels that meet the current and proposed MCLs for drinking water. The ECFI process can attain the lower, proposed arsenic limit of 5 μg/L for approximately one-third of the material costs (reagents) associated with the SBAE process. The difference in material cost for the two processes is largely related to the greater demand for reagents and the high probability of frequent resin replacement for the SBAE process. The lower than expected bed volume capacity for arsenic and the effects of high initial alkalinity contribute to the high reagent demand for the SBAE process. In addition, the influence of alkalinity and sulfate concentrations on these aspects of SBAE makes this process more sensitive to changes in the influent water quality.

Water recovery for the ECFI process would be expected to be 100 percent after recycling of backwash water and filtrate, whereas the SBAE process is predicted to waste between 1 and 2 percent of the process stream. This SBAE waste volume would require treatment with ferric iron in addition to salt recovery in evaporation ponds, and thus produce a residual that is difficult to characterize. For the ECFI process, residuals management is predicted to be simplified based solely on the fact that sludge generated by the process meets TCLP extract criteria for arsenic. For the SBAE process, it was not possible to make the same assessment for the solid residuals generated by treatment, evaporation of spent regenerant, and displacement rinse solutions, because of the small amounts of test materials used. Management of the residuals from the ECFI process would involve thickening, dewatering, and disposal; whereas the SBAE process would likely require at least these three steps for spent regenerant sludge treatment in addition to other steps that involve evaporation and disposal of treated regenerant solutions.

When all aspects of the two processes investigated are considered for treatment of the Fallon groundwater, it becomes clear that the ECFI process presents significant advantages over the SBAE process. These include lower operational cost, a less complicated process (fewer treatment steps), a lower level of treatment residuals management, less material consumption, and a lower degree of sensitivity to changes in the influent water chemistry. Therefore, based on

the information generated in bench-scale testing, it is recommended that enhanced coagulation with iron (with appropriate particulate separation units) be tested in pilot-scale work. This work should be developed and performed in such a manner as to produce data that supports a full-scale design.

7.0 REFERENCES

Clifford, D.A. 1999. Ion Exchange and Inorganic Adsorption. *Water Quality and Treatment.* McGraw Hill, New York. 5th Ed.

FIGURES

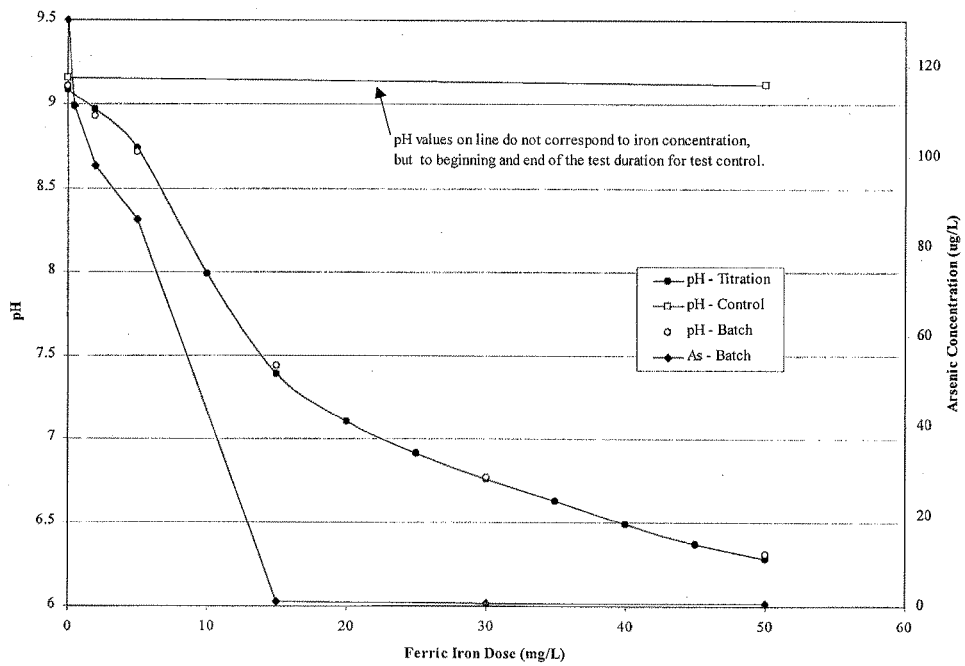

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FIGURE 1
Preliminary Arsenic and pH Values After
Ferric Iron Addition to the City of Fallon Groundwater

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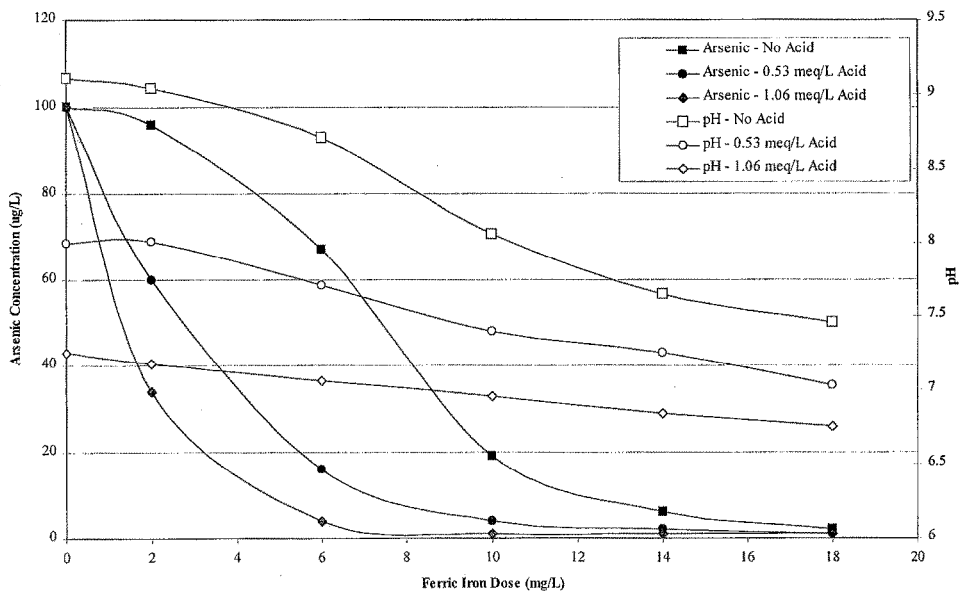

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FIGURE 2
Residual Dissolved Arsenic and Solution pH for
Ferric Iron Coagulation Batch Tests

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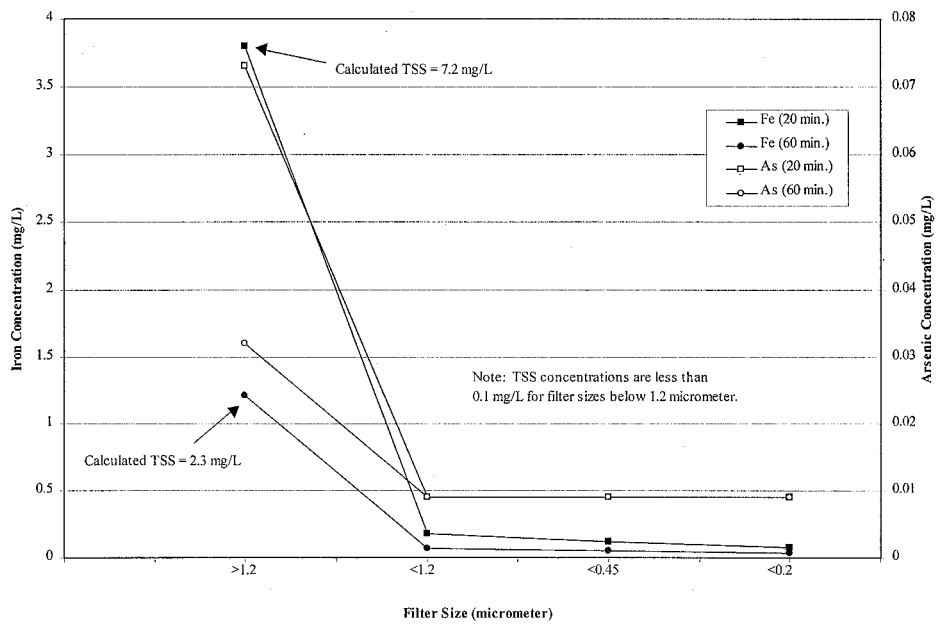

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FIGURE 3
Residual Iron, Arsenic, and Total Suspended Solids After Settling and Size Partitioning - 6 mg/L Ferric Iron Addition

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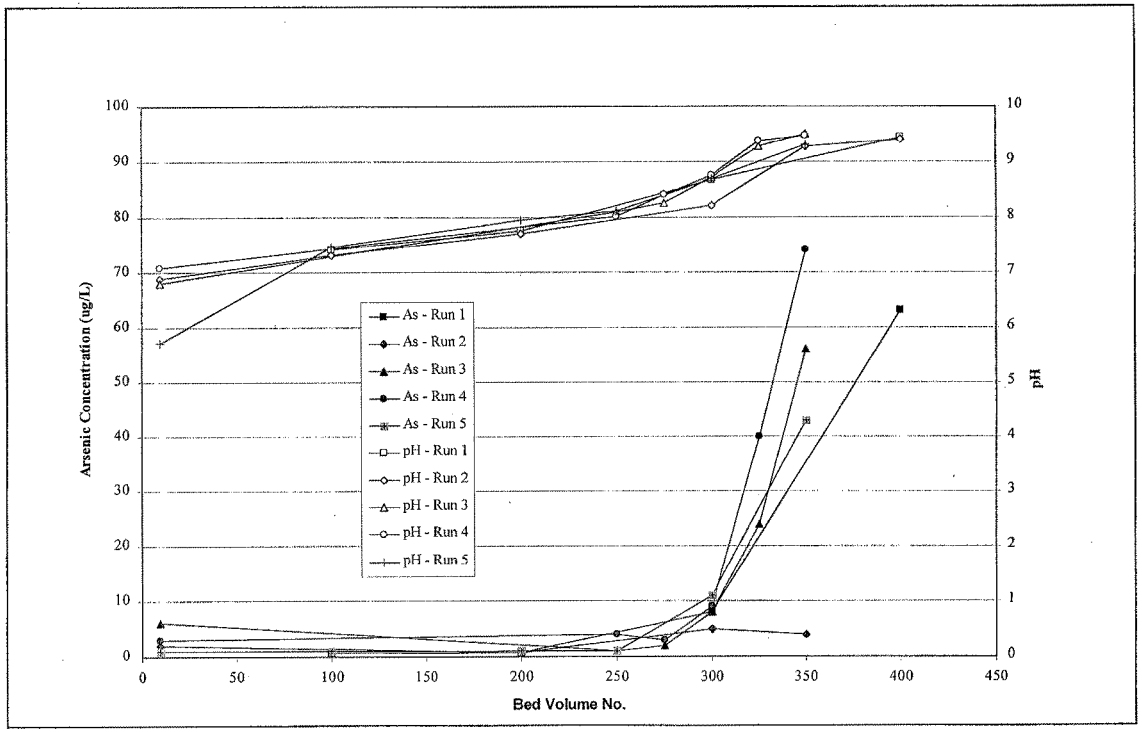

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FIGURE 4
Arsenic Leakage and pH During
Exhaustion Runs of Resin 1

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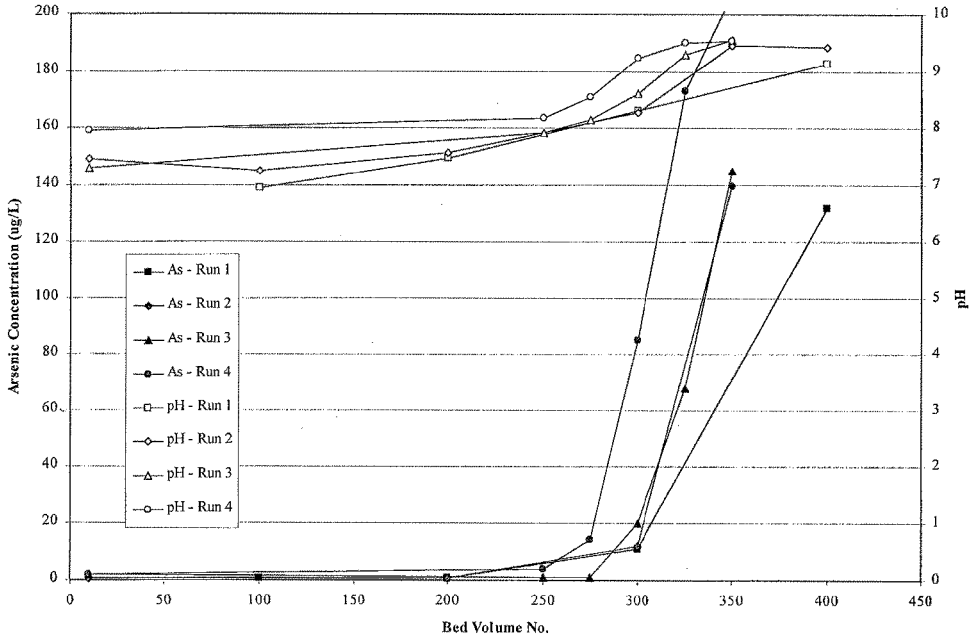

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FIGURE 5
Arsenic Leakage and pH During
Exhaustion Runs of Resin 2

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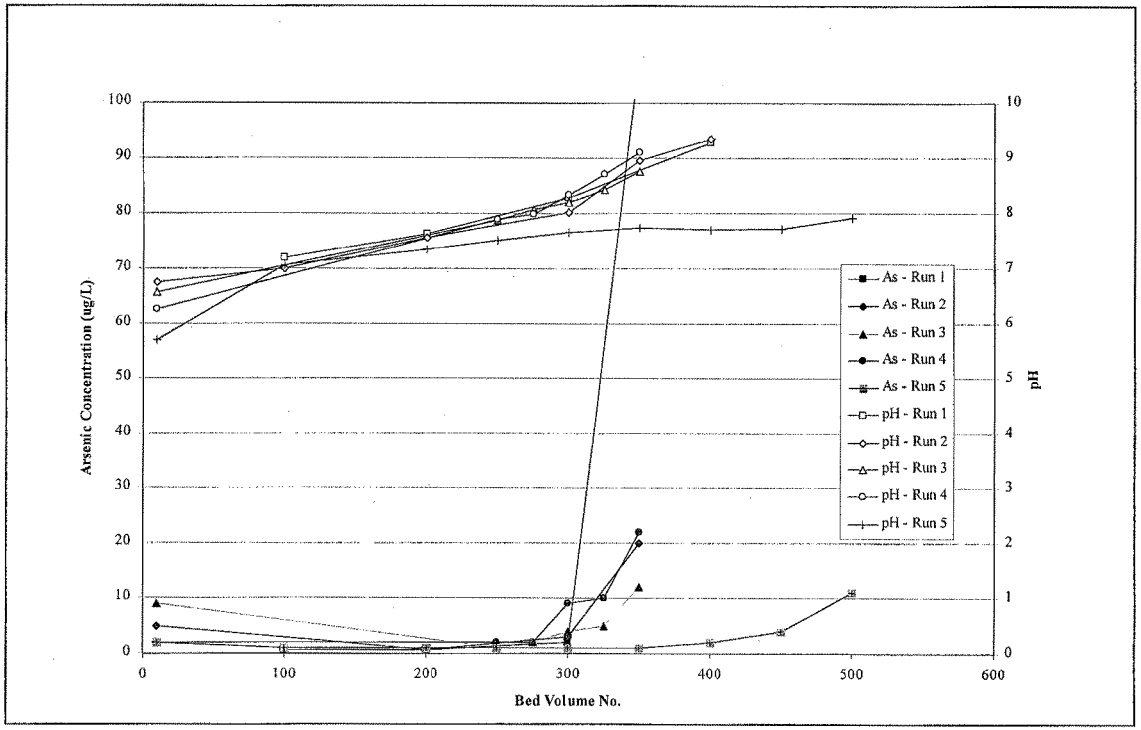

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FIGURE 6
Arsenic Leakage and pH During
Exhaustion Runs of Resin 3

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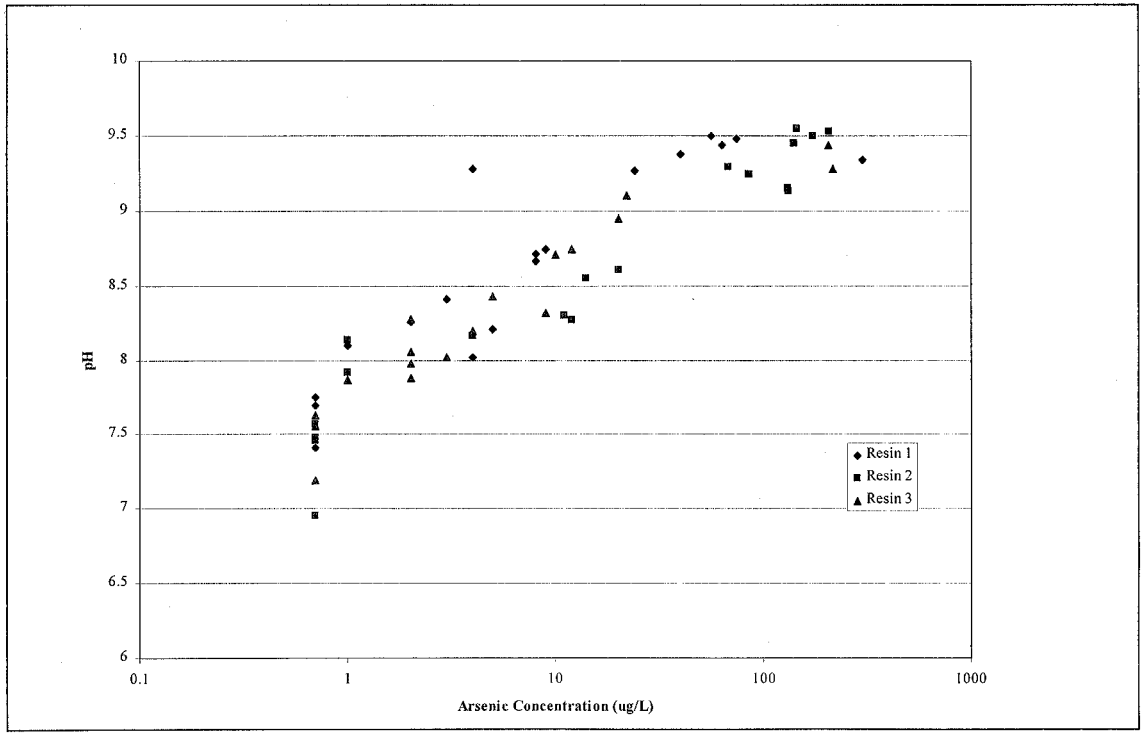

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FIGURE 7
pH versus Arsenic Leakage
During Runs 1 through 4

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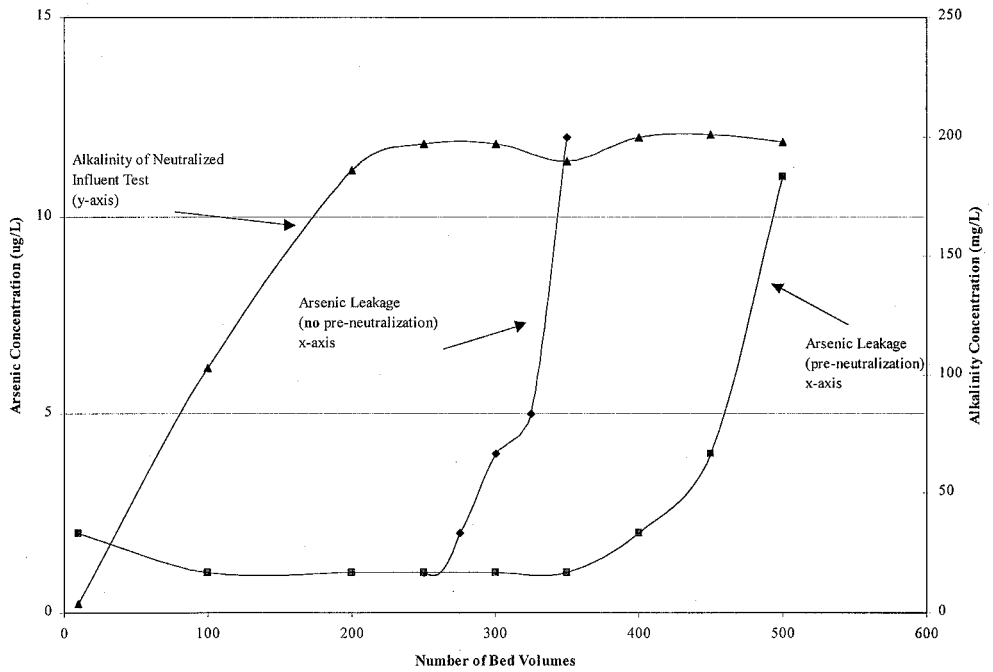

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FIGURE 8
Arsenic Leakage from Resin 3, with and without Pre-neutralization

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DRAFT

GROUNDWATER SAMPLING AND ANALYSIS OF THE CITY OF FALLON AND NAVAL AIR STATION WATER SUPPLY WELLS, FALLON, NEVADA

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September 15, 2000

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1.0 INTRODUCTION

Groundwater samples were collected by Shepherd Miller, Inc. (SMI) and analyzed to establish the general chemistry of public water supply wells used by the City of Fallon and the Naval Air Station (NAS). This report documents: (1) the collection of groundwater samples from wells located within the City of Fallon and wells near the NAS, (2) the laboratory analyses that were performed on these samples, (3) the quality assurance/quality control (QA/QC) measures that were performed to ensure the suitability of the data, and (4) a general evaluation of the water quality.

1.1 Purpose of Investigation

Analyses of previous groundwater samples collected by the City of Fallon and the NAS, have indicated the presence of arsenic at concentrations of approximately 0.1 milligrams per liter (mg/l). This investigation was performed in order to: (1) confirm the results of previous groundwater sampling, (2) determine if arsenic is in the trivalent (3+) form or the pentavalent (5+) form, (3) determine if particulate arsenic (i.e., greater than 0.45 microns) is present, (4) test the effectiveness of aeration in lowering the pH of the water samples, (5) allow a comparison of groundwater quality between the City of Fallon and the NAS wells, and (6) provide information and data necessary to evaluate water treatment options. Information collected during this phase of the work will also be important in helping guide future sampling efforts in terms of analytical detection limits, QA/QC protocols, laboratory selections, and the identification of analytes of concern.

2.0 SAMPLE COLLECTION

2.1 Sample Locations

Groundwater samples were collected from public water supply wells used by the City of Fallon and the NAS. All wells used by the City of Fallon for municipal supply were sampled, these wells are numbered 1 through 4. Two of the three wells used by the NAS were sampled; these wells are numbered 1 and 3. The third NAS supply well was out of production at the time of sampling due to a well screen failure. Table 1 presents a summary of the sampling locations and associated sample identification.

2.2 Analytical Parameters

Laboratory analysis of samples was limited to selected analytes that were needed for evaluation of arsenic treatment options, general chemistry evaluation of the waters, and data validation. As presented in Table 2, sample analyses included cations, anions, metals, radionuclides, and several other parameters. In addition to the laboratory analysis, pH, temperature, electrical conductivity, electromotive force (EMF), ferrous iron, total iron, dissolved oxygen, and turbidity were measured in the field at the time of sample collection.

Collected samples were split and submitted to three laboratories for analysis. The laboratories used for analysis were SVL Analytical Laboratories (SVL) (Kellogg, Idaho), AAL Environmental LLC (AAL) (Reno, Nevada), and Sierra Environmental Monitoring, Incorporated (SEM) (Reno, Nevada). Samples were hand delivered to AAL and SEM the day of sample collection; samples were shipped to SVL by Federal Express. Table 5 summarizes analytes, detection limits, and analytical methods for each of the laboratories. Copies of original laboratory data reports are presented in Appendix A.

Because arsenic was of special interest during this investigation, several types of sample preservation were used. In order to determine the form of arsenic (i.e., trivalent or pentavalent), speciation was performed both in the field and in the laboratories. Section 2.4.8 discusses the method used for speciation of arsenic in the field. Laboratory arsenic speciation was performed

by SEM and SVL. Arsenic speciation was performed by SEM using a procedure derived from Ficklin (1982). Arsenic speciation was performed by SVL using a procedure derived from Subramanian and Meranger (1984).

2.3 Sample Collection Procedures

All groundwater samples were collected, preserved, and analyzed following SMI standard operating procedures (SOPs), which are derived from standard industry and EPA protocols. The SMI SOPs include procedures for the following activities performed during this investigation: (1) decontamination, (2) field instrument calibration, (3) groundwater sample collection, (4) sample labeling, preservation, handling, and shipping, (5) chain-of-custody (COC) procedures, and (6) QA/QC samples and data validation procedures.

Sample collection procedures were designed to ensure that the samples collected would be representative of the sampled matrix. Data sheets were used in the field to record groundwater sample collection data and to document sample collection procedures used. A field data sheet was completed for each groundwater sample location; copies of these sheets are presented in Appendix B.

The general procedure and order for sampling of each well consisted of: (1) calibration of field instruments, (2) equipment decontamination, (3) purging of the well, (4) labeling of sample bottles during purging, (5) collection of a composite groundwater sample, (6) measurement of field parameters, (7) filling of sample bottles, (8) preservation of samples, (9) preparation of COC paperwork, and (10) delivery or shipping of samples to the laboratories. In order to minimize the possibility of cross contamination, new disposable latex gloves, tygon™ tubing, and 0.45 micron filters were used at each sample location. In order to reduce potential sources of variability between the laboratories, only one supplier was used for bottles, acids, and blank water. All sample bottles used were new and factory precleaned with an accompanying certificate of analysis. All preservatives were added after sampling; pre-preserved sample bottles were not used.

With the exception of the NAS well #1, all wells were purged a minimum of 10 saturated borehole volumes prior to sampling. Due to the lower flow rate at the NAS well #1,

approximately seven saturated borehole volumes were purged. Flow rates were measured using inline flow meters. Purge rates and volumes are presented in Appendix B on the field data sheets.

During or prior to purging, the chlorination system was turned off at each individual well. After purging, samples were collected from a sampling port installed on the pump discharge pipe. For all samples except radon, groundwater samples were collected by first rinsing and then filling two decontaminated 5-gallon buckets with sample water. New tygon™ tubing and a peristaltic pump were used to transfer the sample from the buckets to the individual sample bottles. For all samples except radon, the sample bottles were rinsed three times with sample water before filling. Because excessive aeration and bottle rinsing can cause false analytical results for radon, radon sample bottles were filled directly from the sampling port at low flow rates and without rinsing. Disposable latex gloves were worn during sample collection and handling.

2.4 Field Parameter Measurement and Testing

Sample pH, temperature, conductivity, electromotive force (EMF), ferrous iron, total iron, dissolved oxygen, and turbidity were measured for each groundwater sample. Tables 3 and 23 summarizes the field parameter measurements for all samples.

2.4.1 Temperature and pH

Temperature and pH were measured with a Hach Sension 1 pH meter. The pH meter was calibrated daily following a three-point calibration procedure specified by the manufacturer.

2.4.2 Electrical Conductivity

Electrical conductivity was measured with a Hach Sension 5 conductivity/total dissolved solids (TDS) meter. The calibration was checked daily with two standard solutions, and recalibrated if necessary.

2.4.3 Eh

Using an Eh meter with a platinum electrode/reference electrode pair (Hanna Model HI98201 ORP Tester), the EMF of each sample and of a Zobell standard solution were successively

measured. The corrected sample EMF was calculated from the following equation (American Public Health Association, 1992):

$$EMF_{sample,\ corrected} = EMF_{sample,\ measured} + (EMF_{Zobell,\ reference} - EMF_{Zobell,\ measured})$$

where: $EMF_{sample,\ measured}$ = the measured EMF of the sample

$EMF_{Zobell,\ reference}$ = the published EMF reference value of the Zobell solution, corrected to the sample temperature

$EMF_{Zobell,\ measured}$ = the measured EMF of the Zobell temperature, corrected to the sample temperature.

The EMF values of the Zobell solution were corrected to the sample temperature based on the manufacturer's instruction sheet. The Eh of the sample was then calculated by adding the EMF of the reference electrode, as follows:

$$Eh_{sample} = EMF_{sample,\ corrected} + EMF_{Ag/AgCl}$$

where: $EMF_{Ag/AgCl}$ = EMF of the reference silver/silver chloride electrode (approximately 220 mV).

Table 23 presents the Eh calculations for each of the samples.

2.4.4 Iron

Both total and ferrous iron concentrations were measured with a Hach DR890 colorimeter and Hach AccuVac™ FerroVer (total) and ferrous reagents. The colorimeter was calibrated at the SMI laboratory prior to use in the field. The manufacturer's directions were followed for iron measurements.

2.4.5 Dissolved Oxygen

Dissolved oxygen concentrations were measured with a Hach DR890 colorimeter and Hach AccuVac™ dissolved oxygen reagents. The colorimeter was calibrated at the SMI laboratory prior to use in the field. The manufacturer's directions were followed for dissolved oxygen measurements. Due to the high flow rate and turbulence involved in filling the sample buckets, dissolved oxygen results are believed to be unreliable (i.e., too high).

2.4.6 Turbidity

Turbidity was measured in the field with a Hach 2100P turbidimeter directly in nephelometric turbidity units (NTUs). The calibration was checked daily with three standard solutions and was recalibrated if necessary.

2.4.7 Sample Aeration

Groundwater collected from several of the City of Fallon and NAS wells was aerated to determine the effect on pH. Aeration was performed by placing sample water in a 500 milliliter beaker and bubbling air through the sample using an air pump for periods of time ranging from 1.5 to 3 hours. The results of the aeration are presented in Table 4.

2.4.8 Arsenic Speciation

Arsenic speciation was performed in the field at the time of sample collection. Methods described in Edwards and others (1998), modified from Ficklin (1982), were used to perform the field speciation. The general procedure used for arsenic speciation consisted of: (1) collecting a groundwater sample for arsenic speciation, (2) filtering the sample using a new 0.45 micron filter, (3) acidifying the sample with hydrochloric acid to lower the sample pH to between 2 and 3, (4) splitting the acidified sample into two portions, (5) rinsing and filling an arsenic (+5F) bottle with one portion of the sample, (4) rinsing the ion-exchange column with 30 milliliters of the second sample portion, (5) rinsing the decontaminated collection beaker with the ion exchange effluent, (6) running 150 ml of the second sample portion through the ion-exchange column, (6) rinsing and filling an arsenic (+3F) sample bottle with the column effluent, and (7) preserving the arsenic species using additional hydrochloric acid to lower the pH to less than 2.

The high density polyethylene (HDPE) ion-exchange columns were prepared in the SMI laboratory prior to use in the field, using ion exchange resin obtained from the manufacturer in acetate form. The exchange capacity for the columns was calculated to ensure that breakthrough of arsenic (5+) did not occur. Measured sample volumes were run through the columns to insure that no more than about one-third of the ion exchange capacity was used during field arsenic speciation.

2.5 Sample Preservation and Filtration

All samples were preserved as specified in Table 2. Chemical preservatives were added in the field after sample collection. All samples were packed in bags and placed on ice after sample collection. Sample filtration was accomplished using disposable in-line 0.45-micron filters and a peristaltic pump.

2.6 Equipment Decontamination

In order to prevent cross contamination, all equipment that contacted the water samples was decontaminated before its initial use and between use at each sampling site. Supplies (such as disposable filters and sampling bottles) that were certified clean by the manufacturer were not decontaminated or reused. The only equipment that required decontamination were the beakers used for field parameters and the 5-gallon sample buckets. Decontamination was conducted as follows:

- The beakers and buckets were washed with a Liquinox™ solution, triple rinsed with distilled water, triple rinsed with deionized water and, if possible, allowed to air dry. Brushes were used as necessary to ensure thorough cleaning.
- The beakers and buckets were triple rinsed with sample water prior to collection of the sample.
- Clean, disposal surgical gloves were worn during decontamination and when handling decontaminated equipment.

2.7 Quality Assurance/Quality Control

Sample collection and analysis included rigorous QA/QC procedures that were designed to ensure that the data from the samples would be suitable for the intended use of evaluation of arsenic treatment options, general chemistry evaluation of the waters, and data validation. As part of the QA/QC procedures, field duplicate and blank samples were submitted to the laboratories with the primary samples. The laboratory also generated internal replicate (identified as "duplicate" on the laboratory data sheets) samples, spike samples, control samples, and blank samples. The QA/QC procedures and analytical results are discussed in Section 3.0.

3.0 QUALITY ASSURANCE/QUALITY CONTROL VALIDATION

Samples that were collected to characterize groundwater quality are referred to as "investigative" samples. In addition to the investigative samples, field and laboratory QA/QC samples were also collected and analyzed to evaluate the reliability and potential bias of the investigative sample results. QA/QC samples collected by SMI included a field blank and a field duplicate. QA/QC samples prepared by the laboratory included a laboratory blank, laboratory replicate, laboratory matrix spike, and a laboratory control sample. All QA sample results were evaluated. However, because they are internal laboratory QC samples, the laboratory blank and laboratory control sample results are not reproduced in this report.

The sample data package was reviewed using several evaluation criteria from the U.S. Environmental Protection Agency (EPA) *National Functional Guidelines for Inorganic Data Review* (U.S. EPA, 1994a). These criteria are described in Section 3.1. The results of the QA/QC evaluation is presented in Section 3.2.

Section 3.2 summarizes the QA/QC results. The analytical results were qualified based upon the outcomes of several internal or external Quality Control (QC) checks. Analytical results affected by QC checks that exceeded the acceptance limits were qualified with either a "J" code or a "U" code. A "J" code signifies that the associated QC outlier indicated a possible quantitation problem. For example, if the matrix spike recovery was outside the limits, an associated result would have a "J" code attached to that analytical result to indicate the result may not be quantitatively accurate. A "U" code is attached to an analytical result to indicate that the detection limit for that individual analyte in that particular sample has changed from the usual detection limit. For example, if contamination is found in a blank sample, an associated result would have a "U" code attached to that analytical result to indicate the sample may contain any amount of the analyte up to, but not including or exceeding, the analytical result. The determination of "J" and "U" coding is based on several EPA criteria which are described in the following sections.

Tables 2 and 5 present the preservation and holding time requirements, and the analytical methods and associated detection limits, respectively. Tables 6 through 11 present the analysis results of the QC samples associated with this project. Tables 12 and 13 provide comparisons of the arsenic results and Table 14 presents a comparison of the cation-anion charge balances. The analytical results based on QA/QC analysis for each of the field samples is provided in Tables 15 through 22.

3.1 Evaluation Criteria

3.1.1 Blank Samples

No target analytes should be found in laboratory or field blanks. Blank contamination, if found, was evaluated using U.S. EPA (1994a) functional guidelines. The guidelines specify that sample concentrations less than five times the amount detected in associated blanks should be qualified as nondetected ("U") at the reported concentrations.

The field blank sample was prepared at the sample site by pouring industrial Type II deionized water provided by SVL into the decontaminated 5-gallon buckets. The deionized water was then pumped (for total analysis) and filtered (for dissolved analysis) from the 5-gallon buckets into sample bottles. New tygon™ tubing and a 0.45 micron filter were used for the pumping and filtering. The field blank was prepared to assess the potential sample bias due to field conditions, decontamination procedures, tubing contamination, or filter contamination.

3.1.2 Laboratory Spike and Control Samples

3.1.2.1 Laboratory Matrix Spike Samples

Laboratory matrix spike samples are used to evaluate potential matrix effects on sample analysis for inorganic parameters. Percent recoveries of target analytes from matrix spike samples should fall within control limits of 75 to 125 percent. These limits are only applied to analytes where the spike amount added by the laboratory is at least 25% of the analyte concentration in the original unspiked investigative sample.

If the matrix spike recovery is outside the limits, the data are coded with a "J" to designate the quantitation may be impacted by matrix effects. Matrix interference and other effects may cause low or high percent recoveries in investigative samples. Matrix effects may be noted at the same time that recoveries from laboratory control samples indicate acceptable method performance.

3.1.2.2 Laboratory Control Samples

A laboratory control sample (LCS) is a commercially prepared sample with a known concentration that is analyzed by the laboratory to determine if instruments are calibrated and working properly. U.S. EPA guidelines specify that percent recoveries of most metals from aqueous LCSs should fall within control limits of 80 to 120 percent. If any analyte falls outside these limits, any field samples analyzed in the same analytical run as the failed LCS will be qualified with a "J" code to document the quantitation may not be accurate at that value.

3.1.3 Laboratory Replicate and Field Duplicate Samples

3.1.3.1 Laboratory Replicate Samples

Based on U.S. EPA guidelines, aqueous laboratory replicate samples and the samples from which they are split (the investigative samples) should have relative percent differences (RPDs) whose absolute values do not exceed 20 percent in cases where both sample values are greater than or equal to five times the reporting limit. The RPD is defined by the following equation:

$$\text{RPD} = \frac{sample - duplicate\ values}{\left(\frac{sample + duplicate\ values}{2}\right)} \times 100\%$$

If one or both values are less than five times the reporting limit, the difference between the primary and replicate values should not exceed the reporting limit.

The samples to be used by the laboratory for laboratory replicate analysis were identified on the COC record by the sampler.

3.1.3.2 Field Duplicate Samples

For this project, a true field duplicate (not a split replicate) sample was collected immediately after an investigative sample at the same station and in the same fashion as the investigative sample. A new filter (for dissolved analysis) and new tubing were used to collect the field duplicate sample.

Comparing investigative and field duplicate sample results allows assessment of the repeatability of the sample collection process and of the reliability of laboratory analysis procedures. There are no U.S. EPA criteria for field duplicate sample comparability.

3.1.4 Holding Times

The holding times between sample collection and laboratory analysis were reviewed using U.S. EPA guidelines from 40 CFR 136 (U.S. EPA, 1995). The holding times are given in Table 2.

3.1.5 Cation-Anion Charge Balances

Cation-anion charge balances were reviewed as an overall check on analytical accuracy. A 0.0% charge difference between the cations and anions is ideal, and results from laboratories that have large balance differences (i.e., greater than 10%) may be questionable.

3.1.6 Dissolved and Total Concentrations

Sample results were checked to see if dissolved concentrations exceeded total concentrations. Total concentrations should exceed or equal the dissolved concentrations.

3.2 Samples Collected and Analytical Results

Six investigative groundwater samples were collected by SMI from May 23 through May 26, 2000. In addition to the investigative samples, one field duplicate and one field blank sample were collected. Samples were sent to AAL, SEM and SVL in four groups, with each group ranging from one to four samples each. All samples were sent to each lab for analyses under COC documentation, copies of which are contained in Appendix C. The qualified results of these analyses are presented in Tables 15 through 22.

3.2.1 Laboratory and Field Blanks

Minor contamination was detected in the field blank and in the laboratory method blanks. Laboratory results were qualified with a "U" code if an analyte concentration was less than 5 times the concentration of that analyte found in the associated blank. A discussion of blank contamination and the qualified sample results is presented below.

For typical radionuclide analyses and reporting, the results are reported regardless of the reporting limit. Therefore, any blank results that are less than one-fifth the reporting limit are considered acceptable and were not used to qualify samples results at or above the reporting limit. This is because EPA guidelines do not require qualification of sample results if they are at least five times the amount found in the blanks.

3.2.1.1 AAL Blanks

The field blank contained low levels of sulfate, silica, chloride, and color. All investigative sample results were either below the detection limit or exceeded 5 times the amount in the blank, and were therefore not qualified. None of the field blank results for radiological analyses were above the reporting limit. Since radiological analyses are statistically based results, it is possible that radionuclides may be reported at low levels even when they are not present. No radiological results were qualified based upon the field blank analyses.

The laboratory blanks analyzed with the investigative samples contained low levels of color, nitrate/nitrite, TSS, phosphate, and turbidity. Only sample CW-04-01-000526 and the field blank were analyzed for phosphate, and the phosphate result in CW-04-01-000526 was qualified with a "U" code. Color was qualified with a "U" code in all investigative samples, except the field blank. The field blank was not qualified because it is a QC sample and not an investigative sample. Turbidity was qualified with a "U" code in all investigative samples except the field blank, because turbidity was not present above the detection limit in the field blank. TSS and nitrate/nitrite were not qualified, because concentrations for these analytes was below the detection limit in all investigative samples.

A few laboratory blanks for radiological analyses contained low levels of some radionuclides. With the exception of Radium-228, the reporting limit for each of these analytes was a minimum

of 5 times the amount found in the laboratory blank, so no results were qualified. Radium-228 was found in the method blank at 1.067 pCi/L, which is slightly above the reporting limit of 1.0 pCi/L. Radium-228 was qualified with "U" code for all eight samples, because the results were less than 5 times the amount found in the laboratory blank and the blank result was above the reporting limit.

3.2.1.2 SEM Blanks

SEM reported that the field blank contained low levels of total alkalinity, bicarbonate alkalinity, sodium and dissolved arsenic (+3F) (bottle 10, HCl preserved). All investigative sample results were either greater than 5 times the amount in the blank or were below detection limits with the following exceptions, which were qualified with a "U" code: dissolved arsenic (+3F) in investigative samples CW-01-01-000525, CW-01-02-000525, CW-03-01-000525 and CW-04-01-000526. None of the field blank results for radiological analyses were above the reporting limit. Since radiological analyses are statistically based results, it is possible that radionuclides may be reported at low levels even when they are not present. No radiological results were qualified based upon the field blank analyses.

All of the associated laboratory method blanks were free of contamination, although alkalinity, turbidity, color, TDS, and TSS were apparently not analyzed for in the laboratory blank. One of the method blanks had radium-226 at a concentration of 0.260 pCi/L: however, because the radium-226 concentration in the investigative samples was less than the reporting limit, no data were qualified.

3.2.1.3 SVL Blanks

The field blank was found to contain small amounts of turbidity, calcium and magnesium. Therefore, turbidity was qualified as "U" in all investigative samples. The investigative samples contained sufficiently high calcium and magnesium concentrations (i.e., 5 times the blank concentration) to preclude qualification. None of the field blank results were above the reporting limit for radionuclides. Since radiological analyses are statistically based results, it is possible that radionuclides may be reported at low levels even when they are not present. No radiological results were qualified based upon the field blank analyses.

Four laboratory blanks were analyzed by SVL with the investigative samples. Investigative samples were compared only to the laboratory blank associated with that sample. One laboratory blank had low levels of turbidity, silica, and arsenic (+3L). Sample CW-02-01-000523 was qualified as "U" for turbidity. All other investigative sample results associated with the laboratory blank were either below detection limit or greater than 5 times the blank concentration and were not qualified. The second laboratory blank showed detectable concentrations of turbidity, calcium, iron, and arsenic (+3L). Iron in NW-01-01-000524 was qualified as "U"; all other investigative sample results associated with this blank were either below detection limits or greater than 5 times the blank concentration. The third laboratory blank had low levels of turbidity and calcium, and investigative sample CW-03-01-000525 associated with this laboratory blank was qualified as "U" for turbidity. All other investigative sample results associated with this blank were either below detection limit or greater than 5 times the blank concentration. The fourth and final laboratory blank also had low levels of turbidity and calcium. Sample CW-04-01-000526 associated with this blank was qualified as "U" for both turbidity and calcium.

A few laboratory blanks for radiological analyses contained low levels of some radionuclides. With the exception of Radium-228, the reporting limit for each of these analytes was a minimum of 5 times the amount found in the laboratory blank, so no results were qualified. Radium-228 was found in the method blank at 1.067 pCi/L, which is slightly above the reporting limit of 1.0 pCi/L. Radium-228 was qualified with "U" code for all eight samples, because the results were less than 5 times the amount found in the laboratory blank and the blank result was above the reporting limit.

3.2.2 Laboratory Matrix Spike Samples

Matrix spikes were performed by all of the laboratories. AAL spiked one sample, while SVL and SEM spiked multiple samples. This QC evaluation was based on EPA percent recovery limits of 75-125% and the spike concentration added at least 25% of the analyte concentration The matrix spike recoveries are presented in Table 7 for AAL and SVL, with the recoveries for SEM shown in Table 8.

3.2.2.1 AAL Matrix Spikes

AAL performed the matrix spike on sample CW-02-01-000523. All of the recoveries were within the acceptable range. Spikes were not performed for radionuclides, bicarbonate alkalinity, carbonate alkalinity, hydroxide alkalinity, turbidity, color, TSS, and dissolved chromium

3.2.2.2 SEM Matrix Spikes

SEM performed matrix spiking on two of the City of Fallon investigative samples, for many of the analytes. Most of the remaining analytes were spiked by SEM on samples from other projects and investigations. Typically, this would preclude the evaluation of matrix effects for those analytes where the spike was performed on other samples (non-City of Fallon or NAS samples). However, due to the spikes having generally acceptable recoveries, and since the City of Fallon samples do not show unusual analyte concentrations, it is unlikely that serious matrix effects would have been observed if all analytes had been spiked in City of Fallon samples.

Matrix spikes were performed on two different City of Fallon samples, with the exception of arsenic (+5F), arsenic (+5L) and arsenic (+3L), which only had one sample spiked. Chloride, nitrate, and nitrate were spiked into three City of Fallon samples. The following analytes were not spiked into any City of Fallon samples: radionuclides, all four alkalinities, pH, turbidity, color, TDS, TSS, calcium, magnesium, potassium, sodium, silica, total phosphorus, and arsenic (+3F).

With the exception of iron and aluminum, matrix spike recoveries were acceptable. In some cases, the iron and aluminum spike recoveries fell within the 75-125% acceptable limit and in some cases these analytes were outside the acceptable range. Because the concentrations of aluminum and iron were below the detection limit in the samples associated with the matrix spikes that failed, no data were qualified.

Matrix spike duplicates were also performed on a number of analytes. These matrix spike duplicates showed the same general results as the matrix spikes; however, the recovery of arsenic (+5L) was 136%, which exceeds the EPA guidance of 125% for laboratory replicates.

Since the matrix spike recovery was acceptable for arsenic (+5L), and matrix spike duplicates are not required by the EPA, no analyses were qualified.

3.2.2.3 SVL Matrix Spikes

A total of four samples were spiked by SVL. The samples spiked included CW-01-01-000525, CW-02-01-000523, CW-04-01-000526 and NW-01-01-000524. All of the spike recoveries were within acceptable limits, with the exception of total arsenic, arsenic (+3F), and potassium in one of the spiked samples. One of the spikes showed a 148 percent recovery for total arsenic, a 128% recovery for arsenic (+3F) and a 69 percent recovery for potassium; however, all of these analytes were also spiked into three other samples and all of these results were within acceptable limits, so no data were qualified. SVL did not spike radionuclides, arsenic (+5L), any alkalinities, turbidity, color, TDS, or TSS.

3.2.3 Laboratory Control Samples

The recoveries from this QC sample were generally acceptable for all laboratories. A LCS was not performed by each laboratory for every analyte. The following sections provide the results of the LCS review for each laboratory. The EPA limits of 80-120% recoveries were used for LCS evaluation.

3.2.3.1 AAL Laboratory Control Sample

Total arsenic, lead, and silver all failed the LCS criteria with 76, 68 and 71 percent recoveries, respectively. All results for these analytes were coded "J". Bicarbonate alkalinity, carbonate alkalinity, hydroxide alkalinity, color, silica, dissolved chromium, total unpreserved arsenic, arsenic (+3F), and dissolved arsenic did not have an LCS performed. Data were not qualified due to these omissions.

3.2.3.2 SEM Laboratory Control Sample

All LCS percent recoveries were within acceptable limits. Alkalinity (all forms), color, pH, silica, TSS, and TDS analyses did not have an LCS performed. No data were qualified due to these omissions.

3.3.3.3 SVL Laboratory Control Sample

All LCS percent recoveries were within acceptable limits.

3.2.4 Laboratory Replicate and Field Duplicate Samples

3.2.4.1 Field Duplicate

A duplicate sample was collected at Fallon City Well #1 and submitted as a normal investigative sample (blindly) to each of the laboratories. This duplicate sample allows a precision check of both the sampling procedures, sampling equipment, and the laboratory results. The duplicate and associated investigative samples were analyzed for all analytes by all of the laboratories. The results were generally quite good, with the specific laboratory results discussed in the following sections. The EPA recognizes that the precision limit for true field duplicates is much more difficult to achieve than with laboratory duplicates; therefore, the EPA does not require data qualifications based upon field duplicate results. No data were qualified using the EPA guidance and the precision seen in the field duplicate was quite good, with only scattered outliers. The results of the field duplicate are presented in Table 9.

3.2.4.1.1 AAL Field Duplicate

Turbidity, silica, and selenium exceeded the strict laboratory limit of 20 percent RPD. These exceedences were not considered serious because these analytes were found at relatively low concentrations in the samples and other analyte results were acceptable. No data were qualified based on field duplicate analysis.

3.2.4.1.2 SEM Field Duplicate

All analytes were within the precision limits for SEM. The EPA does not require data qualifications based upon the field duplicate RPDs.

3.2.4.1.3 SVL Field Duplicate

Turbidity and TSS exceeded the strict laboratory limit of 20 percent RPD. These analytes were found at low concentrations in the samples and all other analytes were within the acceptable

limit. The EPA does not require data qualifications based upon the field duplicate RPDs and no data were qualified based on field duplicate analysis.

3.2.4.2 Laboratory Replicate

Most replicate precision results were within acceptable limits of 20 percent RPD. The replicate precisions for each laboratory are discussed in the following sections. Table 10 presents the laboratory duplicate results for AAL and SVL, and Table 11 gives the SEM laboratory duplicate results.

3.2.4.2.1 AAL Laboratory Replicate

All non-radiological replicate precisions were within the limit of 20 percent RPD. AAL did not perform replicate analysis of radium-226, TSS, hydroxide alkalinity, pH, turbidity, and color. Criteria for laboratory replicate precision for radiological analytes are not established by EPA, so no radiological results were qualified based on laboratory replicate analysis. No other results were qualified based upon the laboratory replicates.

3.2.4.2.2 SEM Laboratory Replicate

SEM performed laboratory replicates on a very limited basis. Replicate analyses were performed on color, pH and TSS. The replicate precisions for these analytes were within the control limits. SEM performed most replicate analyses on a replicate of the matrix spike. Most, but not all, analytes were analyzed on both the matrix spike and the matrix spike replicate. The precision of the matrix spike and matrix spike replicate was acceptable for all analytes except arsenic (+5L), which had an RPD of 23 percent. Replicates were not performed for the radiological analytes on project samples. Rather, the laboratory control samples were analyzed in replicate. No radiological results were qualified based on lack of replicate analysis.

The EPA rules dictate that a replicate be performed on an non-spiked sample. Because of a lack of non-spiked replicate data, this criterion could not be directly evaluated following EPA rules.

3.2.4.2.3 SVL Laboratory Replicate

SVL performed replicate analyses on a total of four City of Fallon samples. The results of the replicate analysis were good, with only one (of four) total arsenic (unpreserved) result exceeding

the RPD limit. The one total arsenic (unpreserved) result which failed, had an RPD of 31 percent, which exceeds the RPD criteria of 20 percent. The other three replicate samples for this analyte were all within the limit of 20 percent, so no data were qualified. Replicates were performed for all radiological analytes except radium-228 and uranium. Criteria for laboratory replicate precision for radiological analytes are not established by EPA, so no radiological results were qualified.

3.2.5 Holding Times

The elapsed time between sample collection and analysis were evaluated. With the exception of HCl preserved arsenic and unpreserved arsenic, the elapsed holding times were based on EPA limits. The EPA does not specify holding times for HCl preserved arsenic or unpreserved arsenic. For unpreserved arsenic, data were not qualified based on holding times, but the elapsed time between sample collection and analyses is presented in the following laboratory specific sections. Because HCl and HNO_3 preserve samples by acidifying and minimizing adsorption to the sample bottle, and because sufficient HCl was added during sample preservation to lower the sample pH to less than 2, the holding time for arsenic samples preserved with HCl should not be significantly different than for HNO_3 preserved samples. Therefore, the holding time used in this evaluation for HCl preserved total arsenic analyses is 6 months.

Studies performed by Edwards and others (1998) indicate that in some waters the arsenic (5+) and arsenic (3+) species may not be stable, and may convert from one form to the other over time. For the samples that were analyzed for arsenic (5+) and arsenic (3+), a very strict holding time of 3 days was chosen for the speciation to be performed. After speciation, the previously discussed holding time of 6 months for HCl preserved arsenic was used.

3.2.5.1 AAL Holding Times

AAL performed analysis for several analytes beyond the established holding times. Only color in sample CW-02-01-000523 was analyzed outside the established holding times and was therefore qualified with a "J" code. The unpreserved arsenic samples were analyzed between 18 and 21 days after collection.

The holding times for all phosphorus analyses on samples CW-04-01-000526 and CW-04-03-000526 were exceeded, because the requests for these analyses was made by SMI after the holding time limits. Phosphorus data for these samples was qualified with a "J" due to the holding time exceedance.

3.2.5.2 SEM Holding Times

SEM performed analysis for several analytes beyond the established holding times. The following analytes were analyzed outside the established holding times and were qualified with a "J" code: (1) arsenic (+3L) and (+5L) for samples CW-04-01-000526 and CW-04-03-000526, (2) TSS in sample CW-02-01-000523, and (3) TDS in samples CW-02-01-00523, CW-04-01-000526, and CW-04-03-000526. The unpreserved arsenic samples were analyzed between 10 and 13 days after collection.

3.2.5.3 SVL Holding Times

SVL performed analysis for several analytes beyond the established holding times. The following analytes were analyzed outside the established holding times and were qualified with a "J" code: (1) arsenic (+3L) and (+5L) for samples CW-01-01-000525, CW-01-02-000525, CW-03-01-000525, CW-04-01-000526, and CW-04-03-000526, (2) color in samples CW-01-01-000525, CW-01-02-000525, CW-03-01-000525, CW-04-01-000526, and CW-04-03-000526. The unpreserved arsenic samples were analyzed between 6 and 12 days after collection.

The 28 day holding times for all phosphorus analyses were exceeded by 3 to 7 days, because the requests for these analyses was made by SMI after the holding time limits. All phosphorus data was qualified with a "J" due to the holding time exceedance.

3.2.6 Additional Checks for Aqueous Samples

For samples on which both total and dissolved analyses were performed, the total and dissolved results for each sample were compared. In general, the comparisons showed acceptable results. Only the AAL analysis for total versus dissolved arsenic concentration, for sample CW-02-01-000523, exceeded the 20% criteria. The total arsenic concentration for sample CW-02-01-000523 had previously been qualified as "J" (Section 3.2.3.1); therefore, no additional

qualifications were added to this sample. In one additional case for AAL (sample CW-01-01-000525), and three cases for SVL (samples CW-01-01-000525, CW-02-01-000523, and CW-04-01-000526), the dissolved concentrations exceeded the total concentrations for arsenic, but the dissolved and total concentrations were nearly identical (i.e., between 3 and 6 percent), so the data were not qualified.

The cation-anion charge balance was reviewed for each investigative sample. These results allow an additional check on the overall accuracy of the different methods as well as suggest how consistent a laboratory's analysis is for several analytes. The cations used in the calculations were calcium, magnesium, sodium, and potassium. The anions used were sulfate, chloride, nitrate, and alkalinity. The concentrations in mg/L were converted to milliequivalents per liter to normalize the results. A 0.0% charge difference between the cations and anions is ideal. The results of the cation-anion comparisons is presented in Table 14. The cation-anion charge differences for all sample results reported by SEM and SVL were acceptable and did not exceed 5% for any one sample. The cation-anion charge differences for sample results reported by AAL were much higher than either SVL or SEM, and exceeded 20% for one sample. AAL had an average charge difference of 7%, while the SVL and SEM average differences were less than 1%.

3.2.7 Interlaboratory Comparisons

In order to determine which of the laboratories' results are most likely correct, ant to assist the City of Fallon in determining which laboratory to use for future analyses, an interlaboratory comparison was performed. As mentioned earlier, a total of six investigative and two field QC samples were collected during sampling of the Fallon and NAS wells. These samples were then split and a portion of each sample was submitted to each of the three different laboratories for analysis. The interlaboratory evaluation is unusual and is much more subjective than other QC evaluations, and no strict rules exist for this type of evaluation. The interlaboratory evaluation can be as simple as a comparison of the results between the laboratories. A more intensive evaluation may include: (1) a statistical analysis of results, (2) a review of additional internal laboratory QA/QC data, beyond that performed in previous sections, (3) overall usability of the laboratories' analysis results after the QA/QC evaluation, (4) responsiveness of the laboratories,

(5) a comparison of the laboratories analysis costs, (6) sample delivery method (i.e., is the laboratory nearby or must samples be shipped), and (7) a comparison of the clarity, organization, and ease of use of the laboratories' data reports. This interlaboratory evaluation consisted of several items, which are discussed below.

The results from all three laboratories were compared to determine if any trends exist. The data used for this comparison are presented in Tables 15 through 22. Because arsenic is of special interest, emphasis was placed on this comparison and Tables 12 and 13 were prepared to aid in this evaluation. Table 12 presents the arsenic results, grouped by sample location, for each laboratory. Table 13 presents the arsenic results, grouped by species and preservative, for each laboratory. A review of the sample data indicated that AAL reported consistently higher concentrations or values than SEM or SVL for total alkalinity, arsenic (all species and preservation methods), pH, magnesium, potassium, sodium, and silica. SVL reported consistently higher concentrations of sulfate than either AAL or SEM. Of the three laboratories, the lowest values for total alkalinity, pH, and sodium where reported by SVL, and SEM reported the lowest concentrations for nitrate (as nitrogen), magnesium, and potassium. Caution should be used when making comparisons of analyte concentrations, as large percentage differences at low concentrations may not be as meaningful as small percentage differences at high concentrations.

In the original analyses, AAL in a few instances detected the presence of thallium and selenium. Reanalysis by AAL for thallium and selenium, indicates that thallium and selenium are not present above detection limits in any of the samples except CW-02-01-000525. Neither SEM or SVL detected thallium or selenium in any samples. In the original analyses, SEM reported the presence of chromium. Reanalysis by SEM for chromium indicates that while chromium may be present, the original analysis results were probably to high. The reanalysis results for chromium are below the detection limits for SVL and AAL so the accuracy of the reanalysis by SEM can not be evaluated. For the cases when reanalysis was performed, the reanalysis results are presented in the tables and the associated QA/QC is discussed in the preceding sections.

The QA/QC analysis described in previous sections was reviewed to determine if any of the laboratories failed the QA/QC criteria more often than the other laboratories. With the exception of the cation-anion charge balances (Table 14), all the laboratories had similar QA/QC results. The results of the cation-anion balances indicated that AAL results are probably the least reliable in terms of overall accuracy and/or consistency for major analytes. AAL performed total arsenic, lead, and silver analysis even though the laboratory control samples for these analytes did not pass criteria. AAL had the lowest analytical costs.

SVL was the only laboratory that met the reporting deadline and was the most responsive laboratory to requests for additional data and/or data clarification. In addition, the reporting format that SVL used was the easiest to understand. SVL's analytical costs were approximately 15% higher than AAL's analytical costs.

SEM did not analyze for one of the requested non-radiological analytes and several of the radiological analytes. SEM performed a very limited analysis of the requested laboratory replicate sample. SEM's analytical costs were the highest of the three laboratories, and were approximately 25% higher than AAL's analytical costs.

3.2.8 Summary of QA/QC Review

The matrix spike and replicate results were normal for a project of this type, with scattered outliers, but few resulting data qualifications. Analytical results used in the matrix spike and replicate evaluations were not qualified prior to use. This is a conservative approach because qualification prior to use may eliminate some analytes in the investigative samples from qualification by these subsequent methods.

In general, the internal laboratory QC results and the QC results for the field samples were acceptable. None of the evaluation criteria led to excessive data qualifications. As is commonly the case, low concentrations of contamination were found in either the field blanks or laboratory blanks; however, relatively few sample results needed qualification due to the contamination.

4.0 WATER QUALITY DATA EVALUATION

4.1 Stiff Diagrams

Stiff diagrams were constructed as an initial method to evaluate water quality data and are presented in Appendix D. The Stiff diagrams for the samples collected at the City of Fallon and the NAS wells show that the groundwater is an alkaline Na-HCO_3 type water. The City of Fallon and the NAS water samples are remarkable similar, as shown by comparing the concentrations of the cations and anions and the associated Stiff plots between groundwater samples.

4.2 Arsenic Testing and Results

In order to better understand the arsenic present in the City of Fallon and the NAS wells, several tests were performed. The arsenic testing included: (1) speciation, (2) different types of chemical and non-chemical preservation, and (3) filtration. The arsenic tests and results are described in the following sections.

4.2.1 Speciation

Arsenic speciation was performed by SMI in the field and performed by SVL and SEM in their laboratories. SMI and SEM performed arsenic speciation using different variations of the Ficklin (1983) method. SVL performed arsenic speciation using a procedure derived from Subramanian and Meranger (1984).

All arsenic present in the samples collected from the City of Fallon and the NAS wells appears to be in the pentavalent (5+) form. As shown on Table 13, trivalent arsenic (+3) was not detected in any of the investigative samples collected from the City of Fallon or the NAS wells. SEM reported trivalent arsenic (3+) in the field blank (sample CW-04-03-000527), but this value is believed to be incorrect because SEM did not detect total arsenic in this same sample prior to speciation, and SVL did not detect trivalent arsenic in a split of this sample. The AAL result could not be used to evaluate the SEM result because AAL's detection limit was higher than the SEM reported concentration.

4.2.2 Preservation

Several methods of arsenic preservation were used in order to compare the analytical results of this investigation to previous investigations, and to determine if arsenic concentrations varied when using different preservation methods. Arsenic preservation consisted of: (1) preserving with hydrochloric acid, (2) preserving with nitric acid, and (3) placing the samples on ice without using chemical preservation.

As shown on Table 12, there are no consistent differences in reported arsenic results for the three preservation methods. This is an important result because it tends to validate analyses obtained earlier by the City of Fallon.

4.2.3 Filtration

Filtration was performed in the field to determine if particulate arsenic (i.e., greater than 0.45 microns) was present. Filtration consisted of pumping water through a new 0.45 micron filter prior to preservation. The filtration results are presented on Table 12. As presented in Table 12, no consistent differences were observed in the filtered (bottle 5) versus unfiltered (bottle 4) arsenic concentrations, showing that simple filtration using 0.45 micron filters will not be beneficial in water treatment.

4.3 Aeration Effects on pH

Groundwater collected from several of the City of Fallon and NAS wells was aerated to determine the effect on pH. The results of the sample aeration are presented in Table 4. Sample aeration was performed for between 1.5 and 3 hours and resulted in lowering of the pH, of between 0.3 and 0.4 units, for each sample.

In order to determine if the lowering of the pH was due to vigorous aeration or quiescent exposure to the atmosphere, the sample collected at Fallon City Well #4 was split into two equal portions, with one portion aerated and the second portion unaerated. The aerated portion of this sample dropped 0.3 pH units while the pH of the unaerated portion dropped only 0.01 pH units, showing that vigorous aeration was more effective, presumably due to uptake of carbon dioxide gas from the air.

4.4 Water Quality

The City of Fallon and the NAS groundwater is an alkaline Na-HCO_3 type water. The groundwater samples collected and analyzed during this investigation, contained few analytes at concentrations above the laboratories' detection limits. Only the major cations and anions (calcium, magnesium, sodium, potassium, sulfate, chloride, nitrate, and alkalinity), arsenic, fluoride, and silica, were consistently present in concentrations above the detection limits, for each of the laboratories.

5.0 REFERENCES

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TABLES

Table 1. Sample Locations and Identification Numbers

LOCATION	SAMPLE ID
Fallon City Well #1	CW-01-01-000525
Duplicate of City Well #1	CW-01-02-000525
Fallon City Well #2	CW-02-01-000523
Fallon City Well #3	CW-03-01-000525
Fallon City Well #4	CW-04-01-000526
Naval Air Station Well #1	NW-01-01-000524
Naval Air Station Well # 3	NW-03-01-000524
Field Blank	CW-04-03-000526

Table 2. Analytes, Holding Times, and Preservation Requirements

ANALYTE	BOTTLE NO.	DISS. TOTAL	PRESERV.	HOLDING
Alkalinity Total	1	Total	None	14 days
Alkalinity Bicarbonate	1	Total	None	14 days
Alkalinity Carbonate	1	Total	None	14 days
Alkalinity Hydroxide	1	Total	None	14 days
pH	1	Total	None	immediately
Turbidity	1	Total	None	48 hours
Color-Apparent	1	Total	None	48 hours
TDS	2	Dissolved	None	7 days
TSS	1	Total	None	7 days
Nitrate as N	1	Total	None	48 hours
Nitrite as N	1	Total	None	48 hours
NO3 + NO2	3	Total	H_2SO_4	28 days
Calcium	1	Total	None	6 month
Magnesium	1	Total	None	6 month
Potassium	1	Total	None	6 month
Sodium	1	Total	None	6 month
Chloride	1	Total	None	28 days
Fluoride	1	Total	None	28 days
Silica	1	Total	None	28 days
Sulfate	1	Total	None	28 days
Aluminum	4	Total	HNO_3	6 months
Antimony	4	Total	HNO_3	6 months
Arsenic	12	Total	None	Not Established[1]
Arsenic	4	Total	HNO_3	6 months
Arsenic	5	Dissolved	HNO_3	6 months
Arsenic (+3F)	10	Dissolved	HCl	Not Established[1]
Arsenic (+5F)	11	Dissolved	HCl	Not Established[1]
Barium	4	Total	HNO_3	6 months
Beryllium	4	Total	HNO_3	6 months
Cadmium	4	Total	HNO_3	6 months
Chromium	4	Total	HNO_3	6 months
Chromium	5	Dissolved	HNO_3	6 months
Silver	4	Total	HNO_3	6 months
Copper	4	Total	HNO_3	6 months
Iron	4	Total	HNO_3	6 months
Lead	4	Total	HNO_3	6 months
Manganese	4	Total	HNO_3	6 months
Mercury	4	Total	HNO_3	28 days
Nickel	4	Total	HNO_3	6 months
Selenium	4	Total	HNO_3	6 months
Thallium	4	Total	HNO_3	6 months
Zinc	4	Total	HNO_3	6 months
Arsenic (+3L)	6	Dissolved	HCl	not established[1]
Arsenic (+5L)	6	Dissolved	HCl	not established[1]
Phosphorus as P	1	Total	None	28 days
Ortho-Phosphate as P	1	Total	None	48 hours
Gross Alpha	7	Total	HNO_3	6 months
Gross Beta	7	Total	HNO_3	6 months
Radium 226	8,9	Total	HNO_3	6 months
Radium 228	8,9	Total	HNO_3	6 months
Uranium	8,9	Total	HNO_3	6 months
Radon	13	Total	none	48 or 72 hours

[1] = EPA Specified holding times were not found for the HCl preservations or the speciation. A limit of 3 days was used for this project.
F = field
L = lab

Table 3. Field Parameter Results

LOCATION	Fallon City Well #1	Fallon City Well #2	Fallon City Well #3	Fallon City Well #4	Naval Well #1	Naval Well #3
Sample Date	5/25/00	5/23/00	5/25/00	5/26/00	5/24/00	5/24/00
pH (field)	9.16	9.18	9.15	9.14	9.19	9.1
EMF (mV)	265	5	111	141	-5	25
Conductivity (uS/cm)	924	900	925	987	1091	1087
Temp (°C)	19.6	20.4	20.5	20	20.9	22.7
Turbidity (ntu)	0.16	0.51	0.23	0.2	0.27	0.16
Fe Total (mg/L)	0.02	0	0.03	0.01	0.03	0
Fe+2 (mg/L)	0	0	0.02	0.01	0	0
Diss. O2 (mg/L)[1]	5.1	4.2	6	3.8	6.5	6.7

[1]=Unreliable due to purging and sampling method.

Table 4 Results of Sample Aeration

LOCATION	Length of Aeration (hours)	Initial pH	Initial Temp. (°C)	Final pH	Final Temp (°C)
Fallon City Well #1	3	9.16	19.6	8.80	17.9
Fallon City Well #2	1.5	9.18	20.4	8.83	20.1
Fallon City Well #3	NA	NA	NA	NA	NA
Fallon City Well #4	3	9.14	20.0	8.84	22.5
Fallon City Well #4[1]	3	9.14	20.0	9.13	25.7
Naval Well #1	2	9.19	20.9	8.75	20.9
Naval Well #3	2	9.10	22.7	8.77	20.9

[1]=This sample was not aerated but allowed to sit undisturbed next to the aerated sample.

Table 5. Detection Limits and Methods of Analysis

ANALYTE	BOTTLE No.	DISS/ TOTAL	REPORTING LIMITS (mg/L)[1]			EPA METHOD NUMBERS		
			AAL	SEM	SVL	AAL	SEM	SVL
Alkalinity Total	1	Total	1	1	1.0	2320B[2]	310.0	310.1
Alkalinity Bicarbonate	1	Total	1	1	1.0	2320B[2]	310.0	310.1
Alkalinity Carbonate	1	Total	1	1	1.0	2320B[2]	310.0	310.1
Alkalinity Hydroxide	1	Total	1	1	1.0	2320B[2]	310.0	310.1
pH	1	Total	0.1	0.1	0.1	4500H+B[2]	150.1	150.1
Turbidity	1	Total	0.01	0.01	0.02	2130B[2]	180.1	180.1
Color-Apparent	1	Total	5	5	1.0	2120B[2]	110.2	110.2
TDS	2	Diss	10	10	10.0	2540C[2]	160.1	160.1
TSS	1	Total	0.1	1	0.1	2540D[2]	160.2	160.2
Nitrate as N	1	Total	0.1	0.3	0.05	300.0	300.0	300.0
Nitrite as N	1	Total	0.1	0.5	0.05	300.0	300.0	300.0
NO3 + NO2	3	Total	0.1	0.8	0.02	300.0	300.0	353.2
Calcium	1	Total	0.5	0.1	0.013	200.7	200.7	200.7
Magnesium	1	Total	0.1	0.1	0.035	200.7	200.7	200.7
Potassium	1	Total	0.1	0.5	1.700	200.7	200.7	200.7
Sodium	1	Total	0.5	0.1	0.088	200.7	200.7	200.7
Chloride	1	Total	0.2	1.0	0.2	300.0	300.0	300.0
Fluoride	1	Total	0.1	1	0.1	300.0	300.0	300.0
Silica	1	Total	0.025	1	0.080	200.7	370.1	200.7
Sulfate	1	Total	0.4	1	0.3	300.0	200.8	300.0
Aluminum	4	Total	0.02	0.05	0.024	200.7	200.7	200.7
Antimony	4	Total	0.003	0.001	0.001	200.8	200.8	204.2
Arsenic	12	Total	0.005	0.001	0.001	200.8	200.8	206.2
Arsenic	4	Total	0.005	0.001	0.001	200.8	200.8	206.2
Arsenic	5	Diss	0.005	0.001	0.001	200.8	200.8	206.2
Arsenic (+3F)	10	Diss	0.005	0.002	0.001	200.7	200.8	206.2
Arsenic (+5F)	11	Diss	0.005	0.001	0.001	200.7	200.8	206.2
Barium	4	Total	0.02	0.001	0.002	200.7	200.8	200.7
Beryllium	4	Total	0.002	0.001	0.002	200.7	200.8	200.7
Cadmium	4	Total	0.002	0.001	0.0001	200.8	200.8	213.2
Chromium	4	Total	0.005	0.001	0.005	200.7	200.8	200.7
Chromium	5	Diss	0.005	0.001	0.005	200.7	200.8	200.7
Silver	4	Total	0.01	0.001	0.006	200.8	200.8	200.7
Copper	4	Total	0.01	0.001	0.003	200.7	200.8	200.7
Iron	4	Total	0.02	0.05	0.020	200.7	200.7	200.7
Lead	4	Total	0.007	0.001	0.001	200.8	200.8	239.2
Manganese	4	Total	0.005	0.001	0.002	200.7	200.8	200.7
Mercury	4	Total	0.005	0.0005	0.0002	245.1	245.1	245.1
Nickel	4	Total	0.02	0.001	0.023	200.8	200.8	200.7
Selenium	4	Total	0.01	0.001	0.001	200.8	200.8	270.2
Thallium	4	Total	0.001	0.001	0.001	200.8	200.8	279.2
Zinc	4	Total	0.05	0.01	0.003	200.7	200.8	200.7
Arsenic (+3L)	6	Diss	NA	0.002	0.002	NA	Ficklin/200.8	Subr/206.2
Arsenic (+5L)	6	Diss	NA	0.002	0.002	NA	Ficklin/200.8	Subr/206.2
Phosphorus as P	1	Total	NA	<0.02	0.01	NA	365.3	365.2
Ortho-Phosphate	1	Total	0.25	NA	0.01	4500P+C[2]	NA	NA
Gross Alpha pCi/L	7	Total	3	5.0	3	900.0	900.0	900.0
Gross Beta pCi/L	7	Total	4	5.0	4	900.0	900.0	900.0
Radium 226 pCi/L	8,9	Total	1	1.0	1	903.1	903.1	903.1
Radium 228 pCi/L	8,9	Total	1	1.0	1	904	904	904
Uranium pCi/L	8,9	Total	1	0.064	1	908	908	908
Radon pCi/L	13	Total	50.0	50.0	50.0	913.0	SM-7500RN	913.0

Diss = Dissolved
[1] = Units = mg/L, unless otherwise noted in Table
[2] = These methods are American Public Health Association (APHA) methods, not EPA.
F = field
L = lab
NA = Not Analyzed

Table 6. Field Blank Results

ANALYTE	BOTTLE No.	AAL (mg/L)*	SEM (mg/L)*	SVL (mg/L)*
Alkalinity Total	1	< 1	**2**	<1
Alkalinity Bicarbonate	1	< 1	**2**	<1
Alkalinity Carbonate	1	<1	<1	<1
Alkalinity Hydroxide	1	<1	<1	<1
pH	1	6.04	5.58	5.95
Turbidity	1	<0.1	<0.1	0.11
Color-Apparent	1	**5-10**	<5	<5J
TDS	2	<10	<7J	<10
TSS	1	<2	<1	>0.1
Nitrate as N	1	<0.1	<0.1	<0.05
Nitrite as N	1	<0.1	<0.1	<0.05
NO3 + NO2	3	<2	N/A	<0.02
Calcium	1	<0.5	<0.1	0.062
Magnesium	1	<0.1	<0.1	0.048
Potassium	1	<0.1	<0.5	<1.7
Sodium	1	<0.5	**2.7**	<.088
Chloride	1	6.8	<0.1	<0.2
Fluoride	1	<0.1	<0.1	<0.1
Silica	1	**0.109**	<1	<0.17
Sulfate	1	**5.9**	<0.1	<0.3
Aluminum	4	<0.02	<0.05	<0.024
Antimony	4	<0.003	<0.002	<0.001
Arsenic	12	<0.005	<0.002J	<0.001J
Arsenic	4	<0.005J	<0.002	<0.001
Arsenic	5	<0.005	<0.002	<0.001
Arsenic (+3F)	10	<0.005	**0.003J**	<0.001J
Arsenic (+5F)	11	<0.005	<0.002J	<0.001J
Barium	4	<0.02	<0.002	<0.002
Beryllium	4	<0.002	<0.002	<0.002
Cadmium	4	<0.002	<0.002	<0.0001
Chromium	4	<0.005	<0.001	<0.005
Chromium	5	<0.005	<0.001	<0.005
Silver	4	<0.01J	<0.002	<0.006
Copper	4	<0.01	<0.002	<0.003
Iron	4	<0.02	<0.05	<0.02
Lead	4	<0.007J	<0.002	<0.001
Manganese	4	<0.005	<0.002	<0.002
Mercury	4	<0.0005	<0.0005	<0.0002
Nickel	4	<0.02	<0.002	<0.023
Selenium	4	<0.01	<0.002	<0.001
Thallium	4	<0.001	<0.001	<0.001
Zinc	4	<0.05	<0.02	<0.003
Arsenic (+3L)	6	N/A	<0.002J	<0.002J
Arsenic (+5L)	6	N/A	<0.002J	<0.002J
Phosphorus as P	1	N/A	<0.02	<0.01J
Ortho-phosphate as P	1	<0.25	N/A	N/A
Gross Alpha (pCi/l)	7	1.0	<1.0	1.0
Gross Beta (pCi/l)	7	1.0	<1.2	1.0
Radium 226 (pCi/l)	8,9	0.1	N/A	0.1
Radium 228 (pCi/l)	8,9	0.07U	N/A	<0.7U
Uranium	8,9	<0.0001	N/A	<0.0001
Radon (pCi/l)	13	N/A	N/A	N/A

* = units are mg/L, unless otherwise noted in Table
BOLD ENTRIES designate results, which exceeded the reporting limit.
N/A = Not analyzed
F = field
L = lab

Table 7 Matrix Spike Recoveries for AAL and SVL

ANALYTE SAMPLE SPIKED	BOTTLE No.	AAL % Recovery	SVL % Recoveries (4 samples total)			
		CW-02-01-000523	CW-01-01-000525	CW-02-01-000523	CW-04-01-000526	NW-01-01-000524
Alkalinity Total	1	92.4	N/A	N/A	N/A	N/A
Alkalinity Bicarbonate	1	N/A	N/A	N/A	N/A	N/A
Alkalinity Carbonate	1	N/A	N/A	N/A	N/A	N/A
Alkalinity Hydroxide	1	N/A	N/A	N/A	N/A	N/A
pH	1	N/A	N/A	N/A	N/A	N/A
Turbidity	1	N/A	N/A	N/A	N/A	N/A
Color-Apparent	1	N/A	N/A	N/A	N/A	N/A
TDS	2	95.9	N/A	N/A	N/A	N/A
TSS	1	N/A	N/A	N/A	N/A	N/A
Nitrate as N	1	97.0	107	100	101	101
Nitrite as N	1	105.3	99.6	99	107	103
NO3 + NO2	3	N/A	112	**124**	**112**	117
Calcium	1	106.0	92.8	99.2	92.5	97.3
Magnesium	1	106.0	97.5	102.9	96.9	98.2
Potassium	1	125.0	94.7	**69.3**	95.3	101.3
Sodium	1	102.0	R >4S	80	115	R >4S
Chloride	1	104.4	102.6	103.8	108	116
Fluoride	1	100.9	105	105	105	105
Silica	1	92.0	85	95.3	107.5	100
Sulfate	1	107.8	105.6	105.2	105.6	110
Aluminum	4	100.0	92.9	98.9	92.9	95.6
Antimony	4	100.0	118	110	116	102
Arsenic	12	107.6	124	96	108	120
Arsenic	4	102.2	90	90	104	**148**
Arsenic	5	106.7	94	94	122	82
Arsenic (+3F)	10	110.0	110	**128**	98	100
Arsenic (+5F)	11	108.0	R>4S	82	82	120
Barium	4	100.0	95.1	97.1	93.7	99.7
Beryllium	4	106.0	94	101	88.3	96.3
Cadmium	4	94.0	102	94	108	94
Chromium	4	101.0	90	93.8	88.6	95
Chromium	5	N/A	97.4	98.3	96.8	101
Silver	4	96.0	97	97.9	96.7	100
Copper	4	99.0	94.3	97	93.2	97.2
Iron	4	101.0	93.7	97.2	92.8	98
Lead	4	124.0	100	96	92	108
Manganese	4	101.0	92.8	93.5	92	97
Mercury	4	108	110	110	100	110
Nickel	4	95.7	92.9	94.2	87.8	97.1
Selenium	4	121	92	104	102	92
Thallium	4	105	112	108	100	90
Zinc	4	104.0	90.9	95.8	89.1	94.8
Phosphorus as P	1	N/A	100.0	102.0	102.0	98.0
Ortho-phosphate as P	1	N/A	N/A	N/A	N/A	N/A
Arsenic (+3L)	6	N/A	120	112	108	112
Arsenic (+5L)	6	N/A	N/A	N/A	N/A	N/A
Gross Alpha (pCi/l)	7	N/A	N/A	N/A	N/A	N/A
Gross Beta (pCi/l)	7	N/A	N/A	N/A	N/A	N/A
Radium 226 (pCi/l)	8,9	N/A	N/A	N/A	N/A	N/A
Radium 228 (pCi/l)	8,9	N/A	N/A	N/A	N/A	N/A
Uranium	8,9	N/A	N/A	N/A	N/A	N/A
Radon (pCi/l)	13	N/A	N/A	N/A	N/A	N/A

BOLD ENTRIES designate recoveries, which exceed the acceptance criteria.
R>4S = designates the spike added was less than 25% of analyte in unspiked sample. EPA rules state that this occurrence should not be evaluated for matrix spike recovery.
N/A = spike was not performed for this analyte in a Fallon specific sample.
F = field
L = lab

Table 8. Matrix Spike Recoveries for SEM

Analyte	Bottle No.	Sample Spiked CW-01-01-000525
Aluminum	4	66.5
Arsenic	4	94
Iron	4	70.3

Analyte	Bottle No.	Sample Spiked CW-01-02-000525
Antimony	4	112
Barium	4	101
Beryllium	4	102
Cadmium-	4	101
Chromium-	4	89.8
Copper	4	97.8
Lead	4	94.9
Manganese	4	86.9
Nickel	4	101
Selenium	4	112
Silver	4	96.3
Thallium	4	95.4
Zinc	4	100

Analyte	Bottle No.	Sample Spiked CW-03-01-000525
Chloride	1	96
Fluoride	1	97
Nitrate-N	1	101.4
Nitrite-N	1	100.8
Sulfate	1	94

Analyte	Bottle No.	Sample Spiked CW-04-01-000526
Arsenic	4	100
Mercury	4	105.2

Analyte	Bottle No.	Sample Spiked CW-04-03-000526
Arsenic	4	100

Analyte	Bottle No.	Sample Spiked CW-02-01-000523
Aluminum	4	92.4
Antimony	4	97.8
Arsenic	4	102
Arsenic (+3F)	10	108
Arsenic (+5F)	11	108
Barium	4	98.2
Beryllium	4	117
Cadmium	4	100
Chloride	1	98
Chromium	4	89.8
Copper	4	98
Fluoride	1	97.6
Iron	4	97.5
Lead	4	88.2
Manganese	4	104
Mercury	4	104
Nickel	4	100
Nitrate-N	1	101.2
Nitrite-N	1	100.8
Silver	4	94
Sulfate	1	100
Thallium	4	90.8
Zinc	4	87.2

Analyte	Bottle No.	Sample Spiked NW-01-01-000524
Chloride	1	99
Fluoride	1	99.2
Nitrate-N	1	100.8
Nitrite-N	1	99.6

Analyte	Bottle No.	Sample Spiked NW-03-01-000524
Arsenic	4	102

F = field

Table 9. Field Duplicate Results

ANALYTE	Bottle No.	AAL			SEM			SVL		
		Sample	Duplicate	%RPD	Sample	Duplicate	%RPD	Sample	Duplicate	%RPD
Alkalinity Total	1	223	225	0.9	212	214	0.9	201	202	0.5
Alkalinity Bicarbonate	1	170	173	1.7	168	166	1.2	161	162	0.6
Alkalinity Carbonate	1	53	52	1.9	44	48	8.7	40.9	40	2.2
Alkalinity Hydroxide	1	ND	ND	UDL	<1	<1	UDL	<1	<1	UDL
pH	1	9.5	9.52	0.2	9.28	9.25	0.3	9.09	9.08	0.1
Turbidity	1	<0.5U	<0.3U	**50.0**	< 0.1	< 0.1	UDL	0.26	0.47	**57.5**
Color-Apparent	1	<5-10U	<10-15U	0.4	< 5	< 5	UDL	<5J	<5J	UDL
TDS	2	514	532	3.4	520	516	0.8	536	529	1.3
TSS	1	<2	<2	UDL	<1	2	± 1x RL	<0.1	0.4	**FAIL**
Nitrate as N	1	0.4	0.4	0.0	<0.3	<0.3	UDL	0.36	0.35	2.8
Nitrite as N	1	<0.1	<0.1	UDL	<0.5	<0.5	UDL	<0.25	<0.25	UDL
NO3 + NO2	3	<2	<2	UDL	N/A	N/A		0.26	0.24	8.0
Calcium	1	1.37	1.47	7.0	1.3	1.3	0.0	1.54	1.45	6.0
Magnesium	1	0.57	0.635	10.8	0.42	0.43	2.4	0.501	0.463	7.9
Potassium	1	10.7	11.3	5.5	6.8	6.8	0.0	7.1	7.1	0.0
Sodium	1	220	225	2.2	210	190	10.0	196	188	4.2
Chloride	1	98.1	87.2	11.8	91	92	1.1	88.7	89.6	1.0
Fluoride	1	0.6	0.6	0.0	<1	<1	UDL	0.5	0.5	0.0
Silica	1	34.2	16.9	**67.7**	28	28	0.0	28.1	26.8	4.7
Sulfate	1	83.6	83.3	0.4	86	87	1.2	87.4	87.8	0.5
Aluminum	4	0.024	0.024	0.0	<0.05	<0.05	UDL	<0.024	<0.024	UDL
Antimony	4	<0.003	<0.003	UDL	< 0.002	< 0.002	UDL	<0.001	<0.001	UDL
Arsenic	12	0.114	0.11	3.6	0.1J	0.095J	5.1	0.11J	0.096J	13.6
Arsenic	4	0.114J	0.108J	5.4	0.1	0.1	0.0	0.112	0.106	5.5
Arsenic	5	0.113	0.111	1.8	0.1	0.1	0.0	0.106	0.106	0.0
Arsenic (+3F)	10	<0.005J	<0.005J	UDL	<0.002UJ	<0.003UJ	± 1x RL	<0.001J	<0.001J	UDL
Arsenic (+5F)	11	0.109J	0.106J	2.8	0.093J	0.096J	3.2	0.106J	0.1J	5.8
Barium	4	<0.02	<0.02	UDL	< 0.002	< 0.002	UDL	<0.002	<0.002	UDL
Beryllium	4	<0.002	<0.002	UDL	< 0.002	< 0.002	UDL	<0.002	<0.002	UDL
Cadmium	4	<0.002	<0.002	UDL	< 0.002	< 0.002	UDL	<0.0001	<0.0001	UDL
Chromium	4	<0.005	<0.005	UDL	0.001	0.002	± 1x RL	<0.005	<0.005	UDL
Chromium	5	<0.005	<0.005	UDL	<0.001	<0.001	UDL	<0.005	<0.005	UDL
Silver	4	<0.01J	<0.01J	UDL	< 0.002	< 0.002	UDL	<0.006	<0.006	UDL
Copper	4	<0.01	<0.01	UDL	< 0.002	< 0.002	UDL	<0.003	<0.003	UDL
Iron	4	<0.02	<0.02	UDL	<0.05	<0.05	UDL	<0.02	<0.02	UDL
Lead	4	<0.007J	<0.007J	UDL	< 0.002	< 0.002	UDL	<0.001	<0.001	UDL
Manganese	4	<0.005	<0.005	UDL	< 0.002	< 0.002	UDL	<0.002	<0.002	UDL
Mercury	4	<0.0005	<0.0005	UDL	< 0.0005	< 0.0005	UDL	<0.0002	<0.0002	UDL
Nickel	4	<0.02	<0.02	UDL	< 0.002	< 0.002	UDL	<0.023	<0.023	UDL
Selenium	4	<0.01	<0.01	UDL	< 0.002	< 0.002	UDL	<0.001	<0.001	UDL
Thallium	4	<0.001	<0.001	UDL	< 0.001	< 0.001	UDL	<0.001	<0.001	UDL
Zinc	4	<0.05	<0.05	UDL	< 0.02	< 0.02	UDL	<0.003	<0.003	UDL
Phosphorus as P	1	N/A	N/A	N/A	N/A	N/A	N/A	0.22J	0.22J	0
Ortho-phosphate as P	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Arsenic (+3L)	6	N/A	N/A	N/A	< 0.002J	< 0.002J	UDL	<0.002J	<0.002J	UDL
Arsenic (+5L)	6	N/A	N/A	N/A	0.11J	0.11J	0.0	0.102J	0.11J	7.5
Gross Alpha (pCi/l)	7	6	7	± 1x RL	4.2	2.8	± 1x RL	-1	9	± 1x RL
Gross Beta (pCi/l)	7	13	16	± 1x RL	4.0	6.9	± 1x RL	7	7	± 1x RL
Radium 226 (pCi/l)	8,9	0	0.9	± 1x RL	<0.5	N/A	N/A	0.2	0.0	± 1x RL
Radium 228 (pCi/l)	8,9	0	0.8	± 1x RL	N/A	N/A	N/A	1.2	0.5	± 1x RL
Uranium	8,9	0.0026	0.0020	± 1x RL	N/A	N/A	N/A	0.0021	0.0021	± 1x RL
Radon (pCi/l)	13	99	100	± 1x RL	74	96	± 1x RL	90	89	± 1x RL

BOLD ENTRIES designate results that exceed the acceptance criteria.
UDL = Sample and duplicate results were less than the reporting limit, so the results are acceptable.
N/A = Duplicate analysis was not performed for this analyte.
± 1x RL = One or both of the replicate analyses were above the reporting limit, however, the difference between the two results is less than the magnitude of the reporting limit. EPA considers this occurrence within acceptable limits.
FAIL = This designates that one result is less than the reporting limit and the other is not, however, the one result is more than 2 times the reporting limit. The EPA considers this to be outside acceptable limits.
F = field
L = lab

Table 10. Laboratory Replicate Results for AAL and SVL

ANALYTE	Bottle No.	AAL RPDs	SVL RPDs			
		CW-01-01- 000525	CW-02-01-000523	NW-01-01-00524	CW-01-01-000525	CW-04-01-000526
Alkalinity Total	1	0.2	0.9	7	1.5	0.5
Alkalinity Bicarbonate	1	0.1	0.9	3.9	1.2	0
Alkalinity Carbonate	1	0	UDL	19.2	2.7	0.9
Alkalinity Hydroxide	1	N/A	UDL	UDL	UDL	UDL
pH	1	N/A	0.1	1.4	0	0
Turbidity	1	N/A	15.4	2.4	12.2	0
Color-Apparent	1	N/A	UDL	UDL	UDL	UDL
TDS	2	3	0.9	1	0.7	0.2
TSS	1	N/A	UDL	± 1x RL	UDL	0
Nitrate as N	1	1.5	2.7	0	2.8	0
Nitrite as N	1	0.2	UDL	UDL	UDL	UDL
NO3 + NO2	3	UDL	UDL	0	0	0
Calcium	1	0.7	± 1x RL	0.8	1.3	9.5
Magnesium	1	0	8.2	6.2	2.8	9.1
Potassium	1	0.2	2.4	5.6	2.9	10.5
Sodium	1	0.2	0	0.9	1	4.9
Chloride	1	0.7	1.2	2.6	0.9	1
Fluoride	1	1	18.2	0	0	0
Silica	1	0.1	3.3	0	0.4	7.7
Sulfate	1	1.1	0.3	1	2.3	0.3
Aluminum	4	1	UDL	UDL	UDL	UDL
Antimony	4	UDL	UDL	UDL	UDL	UDL
Arsenic	12	0.9	7.6	**31**	15.7	3.2
Arsenic	4	0.2	6.1	0.8	2.7	3
Arsenic	5	0.2	6.3	5.7	1.9	4
Arsenic (+3F)	10	UDL	UDL	UDL	UDL	UDL
Arsenic (+5F)	11	0	15.7	0.9	12	4.8
Barium	4	UDL	UDL	UDL	UDL	0
Beryllium	4	UDL	UDL	UDL	UDL	UDL
Cadmium	4	UDL	UDL	UDL	UDL	UDL
Chromium	4	UDL	UDL	UDL	UDL	UDL
Chromium	5	UDL	UDL	UDL	UDL	UDL
Silver	4	UDL	UDL	UDL	UDL	UDL
Copper	4	UDL	UDL	± 1x RL	UDL	± 1x RL
Iron	4	UDL	UDL	± 1x RL	UDL	UDL
Lead	4	UDL	0	UDL	UDL	UDL
Manganese	4	UDL	UDL	UDL	UDL	UDL
Mercury	4	UDL	UDL	UDL	UDL	UDL
Nickel	4	UDL	UDL	UDL	UDL	UDL
Selenium	4	UDL[2]	UDL	UDL	UDL	UDL
Thallium	4	UDL[2]	UDL	UDL	UDL	UDL
Zinc	4	UDL	UDL	± 1x RL	UDL	± 1x RL
Phosphorus as P	1	N/A	0.0	8.7	0.0	0.0
Ortho-phosphate as P	1	N/A	N/A	N/A	N/A	N/A
Arsenic (+3L)	6	N/A	UDL	UDL	UDL	UDL
Arsenic (+5L)	6	N/A	12.9	5.6	1	2
Gross Alpha	7	Acceptable[3]	N/A	Acceptable	Acceptable	N/A
Gross Beta	7	Acceptable[3]	N/A	Acceptable	Acceptable	N/A
Radium 226	8,9	N/A	N/A	N/A	N/A	Acceptable
Radium 228	8,9	Acceptable[4]	N/A	N/A	N/A	N/A
Uranium	8,9	Acceptable[5]	N/A	N/A	N/A	N/A
Radon	13	Acceptable[6]	Acceptable	N/A	Acceptable	Acceptable[1]

BOLD ENTRIES designate results that exceed the acceptance criteria.
UDL = Sample and replicate results were less than the reporting limit, so the results are acceptable.
N/A = Replicate analysis was not performed for this analyte.
± 1x RL = One or both of the replicate analyses were above the reporting limit, however, the difference between the two results is less than the magnitude of the reporting limit. EPA considers this occurrence within acceptable limits.
FAIL = This designates that one result is less than the reporting limit and the other is not, however, the one result is more than 2 times the reporting limit. The EPA considers this to be outside acceptable limits.

F = field
L = lab

1 = This replicate was performed on sample NW-03-01-000524
2 = This replicate performed on CW-03-01-000525
3 = This replicate was also performed on CW-04-01-000526
4 = This replicate was performed on CW-04-03-000524
5 = This replicate was performed on CW-02-01-000523 and CW-03-01-000525
6 = This replicate was also performed on CW-02-01-000523

Table 11. Laboratory Replicate RPD Results for SEM

ANALYTE	Bottle No.	Sample Replicated CW-02-01-000523
Aluminum	4	0.65
Antimony	4	1.52
Arsenic	4	3.64
Barium	4	0.51
Beryllium	4	3.36
Cadmium	4	1.98
Chloride	1	2.06
Copper	4	2.02
Fluoride	1	1.44
Iron	4	0.1
Lead	4	0.9
Manganese	4	1.9
Mercury	4	0
Nickel	4	1
Nitrate-N	1	0.2
Nitrite-N	1	0.2
pH	1	1.09
Selenium	4	0.88
Silver	4	1.27
Sulfate	1	5.83

ANALYTE	Bottle No.	Sample Replicated CW-04-01-000526
Arsenic	4	1.61
Mercury	4	0.76
TSS	1	0

ANALYTE	Bottle No.	Sample Replicated CW-01-01-000525
Aluminum	4	15.56
Arsenic	4	5.18
Color	1	0
Iron	5	17.65
TSS	1	0

ANALYTE	Bottle No.	Sample Replicated CW-03-01-000525
Chloride	1	0
Fluoride	1	1.87
Nitrate-N	1	0.4
Nitrite-N	1	0.2
Sulfate	1	0

ANALYTE	Bottle No.	Sample Replicated CW-04-03-000526
Arsenic	4	1.61
pH	1	0.36

ANALYTE	Bottle No.	Sample Replicated NW-01-01-000524
Chloride	1	0.2
Fluoride	1	0.4
Nitrate-N	1	0.4
Nitrite-N	1	0.2

ANALYTE	Bottle No.	Sample Replicated NW-03-01-000524
Arsenic	4	1.87

Table 12. Arsenic Comparisons (sorted by sample location)

SAMPLE	BOTTLE No.	PRESERVATIVE	ARSENIC TYPE	AAL	SEM	SVL
CW-01-01-000525	12	Unpres.	Total	0.114	0.1	0.11
CW-01-01-000525	4	HNO_3	Total	0.114J	0.1	0.112
CW-01-01-000525	5	HNO_3	Dissolved	0.113	0.1	0.106
CW-01-01-000525	10	HCl	Dissolved (+3F)	<0.005	<0.002U	<0.001
CW-01-01-000525	11	HCl	Dissolved (+5F)	0.109	0.093	0.106
CW-01-01-000525	6	HCl	Dissolved (+3L)	N/A	< 0.002	<0.002J
CW-01-01-000525	6	HCl	Dissolved (+5L)	N/A	0.11	0.102J
CW-01-02-000525	12	Unpres.	Total	0.11	0.095	0.096
CW-01-02-000525	4	HNO_3	Total	0.108J	0.1	0.106
CW-01-02-000525	5	HNO_3	Dissolved	0.111	0.1	0.106
CW-01-02-000525	10	HCl	Dissolved (+3F)	<0.005	<0.003U	<0.001
CW-01-02-000525	11	HCl	Dissolved (+5F)	0.106	0.096	0.1
CW-01-02-000525	6	HCl	Dissolved (+3L)	N/A	< 0.002	<0.002J
CW-01-02-000525	6	HCl	Dissolved (+5L)	N/A	0.11	0.11J
CW-02-01-000523	12	Unpres.	Total	0.139	0.098	0.114
CW-02-01-000523	4	HNO_3	Total	0.105J	0.11	0.096
CW-02-01-000523	5	HNO_3	Dissolved	0.132	0.099	0.099
CW-02-01-000523	10	HCl	Dissolved (+3F)	<0.005	< 0.002	<0.001
CW-02-01-000523	11	HCl	Dissolved (+5F)	0.108	0.097	0.11
CW-02-01-000523	6	HCl	Dissolved (+3L)	N/A	< 0.002	<0.002
CW-02-01-000523	6	HCl	Dissolved (+5L)	N/A	0.11	0.094
CW-03-01-000525	12	Unpres.	Total	0.0966	0.097	0.116
CW-03-01-000525	4	HNO_3	Total	0.108J	0.1	0.11
CW-03-01-000525	5	HNO_3	Dissolved	0.0959	0.099	0.107
CW-03-01-000525	10	HCl	Dissolved (+3F)	<0.005	<0.002U	<0.001
CW-03-01-000525	11	HCl	Dissolved (+5F)	0.104	0.093	0.092
CW-03-01-000525	6	HCl	Dissolved (+3L)	N/A	< 0.002	<0.002J
CW-03-01-000525	6	HCl	Dissolved (+5L)	N/A	0.12	0.102J
CW-04-01-000526	12	Unpres.	Total	0.0993	0.11	0.094
CW-04-01-000526	4	HNO_3	Total	0.13J	0.10	0.099
CW-04-01-000526	5	HNO_3	Dissolved	0.103	0.10	0.102
CW-04-01-000526	10	HCl	Dissolved (+3F)	<0.005	<0.002U	<0.001
CW-04-01-000526	11	HCl	Dissolved (+5F)	0.11	0.095	0.107
CW-04-01-000526	6	HCl	Dissolved (+3L)	N/A	< 0.002J	<0.002J
CW-04-01-000526	6	HCl	Dissolved (+5L)	N/A	0.12J	0.101J
CW-04-03-000526	12	Unpres.	Total	<0.005	< 0.002	<0.001
CW-04-03-000526	4	HNO_3	Total	<0.005J	< 0.002	<0.001
CW-04-03-000526	5	HNO_3	Dissolved	<0.005	< 0.002	<0.001
CW-04-03-000526	10	HCl	Dissolved (+3F)	<0.005	0.003	<0.001
CW-04-03-000526	11	HCl	Dissolved (+5F)	<0.005	< 0.002	<0.001
CW-04-03-000526	6	HCl	Dissolved (+3L)	N/A	< 0.002J	<0.002J
CW-04-03-000526	6	HCl	Dissolved (+5L)	N/A	< 0.002J	<0.002J
NW-01-01-000524	12	Unpres.	Total	0.124	0.12	0.09
NW-01-01-000524	4	HNO_3	Total	0.146J	0.12	0.119
NW-01-01-000524	5	HNO_3	Dissolved	0.117	0.11	0.126
NW-01-01-000524	10	HCl	Dissolved (+3F)	<0.005	< 0.002	<0.001
NW-01-01-000524	11	HCl	Dissolved (+5F)	0.117	0.099	0.114
NW-01-01-000524	6	HCl	Dissolved (+3L)	N/A	< 0.002	<0.002
NW-01-01-000524	6	HCl	Dissolved (+5L)	N/A	0.13	0.104
NW-03-01-000524	12	Unpres.	Total	0.125	0.12	0.123
NW-03-01-000524	4	HNO_3	Total	0.118J	0.12	0.122
NW-03-01-000524	5	HNO_3	Dissolved	0.118	0.11	0.108
NW-03-01-000524	10	HCl	Dissolved (+3F)	<0.005	< 0.002	<0.001
NW-03-01-000524	11	HCl	Dissolved (+5F)	0.118	0.099	0.108
NW-03-01-000524	6	HCl	Dissolved (+3L)	N/A	< 0.002	<0.002
NW-03-01-000524	6	HCl	Dissolved (+5L)	N/A	0.13	0.1

Unpres. = Unpreserved sample
N/A = Not analyzed. F = field L = lab

Table 13. Arsenic Comparisons (sorted by analyte)

Sample Number	Bottle	Preservation	Type	AAL (mg/L)	SEM (mg/L)	SVL (mg/L)
CW-01-01-000525	12	Unpreserved	Total	0.114	0.1	0.11
CW-01-02-000525	12	Unpreserved	Total	0.11	0.095	0.096
CW-02-01-000523	12	Unpreserved	Total	0.139	0.098	0.114
CW-03-01-000525	12	Unpreserved	Total	0.0966	0.097	0.116
CW-04-01-000526	12	Unpreserved	Total	0.0993	0.11	0.094
CW-04-03-000527	12	Unpreserved	Total	<0.005	< 0.002	<0.001
NW-01-01-000524	12	Unpreserved	Total	0.124	0.12	0.09
NW-03-01-000524	12	Unpreserved	Total	0.125	0.12	0.123
CW-01-01-000525	4	HNO_3	Total	0.114J	0.1	0.112
CW-01-02-000525	4	HNO_3	Total	0.108J	0.1	0.106
CW-02-01-000523	4	HNO_3	Total	0.105J	0.11	0.096
CW-03-01-000525	4	HNO_3	Total	0.108J	0.1	0.11
CW-04-01-000526	4	HNO_3	Total	0.13J	0.10	0.099
CW-04-03-000527	4	HNO_3	Total	<0.005J	< 0.002	<0.001
NW-01-01-000524	4	HNO_3	Total	0.146J	0.12	0.119
NW-03-01-000524	4	HNO_3	Total	0.118J	0.12	0.122
CW-01-01-000525	5	HNO_3	Dissolved	0.113	0.1	0.106
CW-01-02-000525	5	HNO_3	Dissolved	0.111	0.1	0.106
CW-02-01-000523	5	HNO_3	Dissolved	0.132	0.099	0.099
CW-03-01-000525	5	HNO_3	Dissolved	0.0959	0.099	0.107
CW-04-01-000526	5	HNO_3	Dissolved	0.103	0.10	0.102
CW-04-03-000527	5	HNO_3	Dissolved	<0.005	< 0.002	<0.001
NW-01-01-000524	5	HNO_3	Dissolved	0.117	0.11	0.126
NW-03-01-000524	5	HNO_3	Dissolved	0.118	0.11	0.108
CW-01-01-000525	11	HCl	Dissolved (+5F)	0.109	0.093	0.106
CW-01-02-000525	11	HCl	Dissolved (+5F)	0.106	0.096	0.1
CW-02-01-000523	11	HCl	Dissolved (+5F)	0.108	0.097	0.11
CW-03-01-000525	11	HCl	Dissolved (+5F)	0.104	0.093	0.092
CW-04-01-000526	11	HCl	Dissolved (+5F)	0.11	0.095	0.107
CW-04-03-000527	11	HCl	Dissolved (+5F)	<0.005	< 0.002	<0.001
NW-01-01-000524	11	HCl	Dissolved (+5F)	0.117	0.099	0.114
NW-03-01-000524	11	HCl	Dissolved (+5F)	0.118	0.099	0.108
CW-01-01-000525	10	HCl	Dissolved (+3F)	<0.005	<0.002U	<0.001
CW-01-02-000525	10	HCl	Dissolved (+3F)	<0.005	<0.003U	<0.001
CW-02-01-000523	10	HCl	Dissolved (+3F)	<0.005	< 0.002	<0.001
CW-03-01-000525	10	HCl	Dissolved (+3F)	<0.005	<0.002U	<0.001
CW-04-01-000526	10	HCl	Dissolved (+3F)	<0.005	<0.002U	<0.001
CW-04-03-000527	10	HCl	Dissolved (+3F)	<0.005	0.003	<0.001
NW-01-01-000524	10	HCl	Dissolved (+3F)	<0.005	< 0.002	<0.001
NW-03-01-000524	10	HCl	Dissolved (+3F)	<0.005	< 0.002	<0.001
CW-01-01-000525	6	HCl	Dissolved (+3L)	N/A	< 0.002	<0.002J
CW-01-02-000525	6	HCl	Dissolved (+3L)	N/A	< 0.002	<0.002J
CW-02-01-000523	6	HCl	Dissolved (+3L)	N/A	< 0.002	<0.002
CW-03-01-000525	6	HCl	Dissolved (+3L)	N/A	< 0.002	<0.002J
CW-04-01-000526	6	HCl	Dissolved (+3L)	N/A	< 0.002J	<0.002J
CW-04-03-000527	6	HCl	Dissolved (+3L)	N/A	< 0.002J	<0.002J
NW-01-01-000524	6	HCl	Dissolved (+3L)	N/A	< 0.002	<0.002
NW-03-01-000524	6	HCl	Dissolved (+3L)	N/A	< 0.002	<0.002
CW-01-01-000525	6	HCl	Dissolved (+5L)	N/A	0.11	0.102J
CW-01-02-000525	6	HCl	Dissolved (+5L)	N/A	0.11	0.11J
CW-02-01-000523	6	HCl	Dissolved (+5L)	N/A	0.11	0.094
CW-03-01-000525	6	HCl	Dissolved (+5L)	N/A	0.12	0.102J
CW-04-01-000526	6	HCl	Dissolved (+5L)	N/A	0.12J	0.101J
CW-04-03-000527	6	HCl	Dissolved (+5L)	N/A	< 0.002J	<0.002J
NW-01-01-000524	6	HCl	Dissolved (+5L)	N/A	0.13	0.104
NW-03-01-000524	6	HCl	Dissolved (+5L)	N/A	0.13	0.1

Diss = Dissolved analyte N/A = Not analyzed F = field L = lab

Table 14. Cation-Anion Charge Balance Comparisons

Sample	AAL			SEM			SVL		
	Cation	Anion	% Diff.	Cation	Anion	% Diff.	Cation	Anion	% Diff.
City Well #1	10.0	9.0	4.8	9.4	8.6	4.3	8.8	8.4	2.4
Duplicate of Well #1	10.2	8.8	7.6	8.5	8.7	-1.1	8.5	8.5	-0.4
City Well #2	10.0	6.5	21.0	8.6	8.3	1.4	9.1	8.9	1.4
City Well #3	10.2	11.0	-3.4	8.5	8.6	-0.2	8.3	8.5	-1.1
City Well #4	10.9	9.4	7.4	8.5	9.0	-2.6	8.6	9.3	-4.2
Naval Well #1	12.2	9.8	10.9	9.8	9.6	1.2	9.6	9.8	-1.0
Naval Well #3	12.0	9.9	10.0	9.4	9.7	-1.7	9.8	9.9	-0.6
	Average		7.29	Average		0.16	Average		-0.44

% Diff. = Percent Difference between the cation totals and the anion totals; all expressed in milliequivalents/L.

Table 15. Qualified Analytical Results CW-01-01-000525 (Fallon City Well #1)

ANALYTE	Bottle No.	AAL	SEM	SVL
Alkalinity Total	1	223	212	201
Alkalinity Bicarbonate	1	170	168	161
Alkalinity Carbonate	1	53	44	40.9
Alkalinity Hydroxide	1	<1	<1	<1
pH	1	9.5	9.28	9.09
Turbidity	1	<0.5U	< 0.1	0.26
Color-Apparent	1	<5-10U	< 5	<5J
TDS	2	514	520	536
TSS	1	<2	<1	<0.1
Nitrate as N	1	0.4	<0.3	0.36
Nitrite as N	1	<0.1	<0.5	<0.25
NO3 + NO2	3	<2	N/A	0.26
Calcium	1	1.37	1.3	1.54
Magnesium	1	0.57	0.42	0.501
Potassium	1	10.7	6.8	7.1
Sodium	1	220	210	196
Chloride	1	98.1	91	88.7
Fluoride	1	0.6	<1	0.5
Silica	1	34.2	28	28.1
Sulfate	1	83.6	86	87.4
Aluminum	4	0.024	<0.05	<0.024
Antimony	4	<0.003	< 0.002	<0.001
Arsenic	12	0.114	0.1	0.11
Arsenic	4	0.114J	0.1	0.112
Arsenic	5	0.113	0.1	0.106
Arsenic (+3F)	10	<0.005J	<0.002U	<0.001
Arsenic (+5F)	11	0.109J	0.093	0.106
Barium	4	<0.02	< 0.002	<0.002
Beryllium	4	<0.002	< 0.002	<0.002
Cadmium	4	<0.002	< 0.002	<0.0001
Chromium	4	<0.005	0.001	<0.005
Chromium	5	<0.005	<0.001	<0.005
Silver	4	<0.01J	< 0.002	<0.006
Copper	4	<0.01	< 0.002	<0.003
Iron	4	<0.02	<0.05	<0.02
Lead	4	<0.007J	< 0.002	<0.001
Manganese	4	<0.005	< 0.002	<0.002
Mercury	4	<0.0005	< 0.0005	<0.0002
Nickel	4	<0.02	< 0.002	<0.023
Selenium	4	<0.01	< 0.002	<0.001
Thallium	4	<0.001	< 0.001	<0.001
Zinc	4	<0.05	< 0.02	<0.003
Arsenic (+3L)	6	N/A	< 0.002	<0.002J
Arsenic (+5L)	6	N/A	0.11	0.102J
Phosphorus as P	1	N/A	N/A	0.22J
Ortho-Phosphate as P	1	N/A	N/A	N/A
Gross Alpha (pCi/l)	7	6	4.2	-1
Gross Beta (pCi/l)	7	13	4.0	7
Radium 226 (pCi/l)	8,9	0	<0.5	0.2
Radium 228 (pCi/l)	8,9	<0U	N/A	<1.2U
Uranium	8,9	0.0026	N/A	0.0021
Radon (pCi/l)	13	99	74	90

F = field
L = lab

Table 16. Qualified Analytical Results CW-01-02-000525 (Duplicate of Fallon City Well #1)

ANALYTE	Bottle No.	AAL	SEM	SVL
Alkalinity Total	1	225	214	202
Alkalinity Bicarbonate	1	173	166	162
Alkalinity Carbonate	1	52	48	40
Alkalinity Hydroxide	1	<1	<1	<1
pH	1	9.52	9.25	9.08
Turbidity	1	<0.3U	< 0.1	0.47
Color-Apparent	1	<10-15U	< 5	<5J
TDS	2	532	516	529
TSS	1	<2	2	0.4
Nitrate as N	1	0.4	<0.3	0.35
Nitrite as N	1	<0.1	<0.5	<0.25
NO3 + NO2	3	<2	N/A	0.24
Calcium	1	1.47	1.3	1.45
Magnesium	1	0.635	0.43	0.463
Potassium	1	11.3	6.8	7.1
Sodium	1	225	190	188
Chloride	1	87.2	92	89.6
Fluoride	1	0.6	<1	0.5
Silica	1	16.9	28	26.8
Sulfate	1	83.3	87	87.8
Aluminum	4	0.024	<0.05	<0.024
Antimony	4	<0.003	< 0.002	<0.001
Arsenic	12	0.11	0.095	0.096
Arsenic	4	0.108J	0.1	0.106
Arsenic	5	0.111	0.1	0.106
Arsenic (+3F)	10	<0.005	<0.003U	<0.001
Arsenic (+5F)	11	0.106	0.096	0.1
Barium	4	<0.02	< 0.002	<0.002
Beryllium	4	<0.002	< 0.002	<0.002
Cadmium	4	<0.002	< 0.002	<0.0001
Chromium	4	<0.005	0.002	<0.005
Chromium	5	<0.005	<0.001	<0.005
Silver	4	<0.01J	< 0.002	<0.006
Copper	4	<0.01	< 0.002	<0.003
Iron	4	<0.02	<0.05	<0.02
Lead	4	<0.007J	< 0.002	<0.001
Manganese	4	<0.005	< 0.002	<0.002
Mercury	4	<0.0005	< 0.0005	<0.0002
Nickel	4	<0.02	< 0.002	<0.023
Selenium	4	<0.01	< 0.002	<0.001
Thallium	4	<0.001	< 0.001	<0.001
Zinc	4	<0.05	< 0.02	<0.003
Arsenic (+3L)	6	N/A	< 0.002	<0.002J
Arsenic (+5L)	6	N/A	0.11	0.11J
Phosphorus as P	1	N/A	N/A	0.22J
Ortho-Phosphate as P	1	N/A	N/A	N/A
Gross Alpha (pCi/l)	7	7	2.8	9
Gross Beta (pCi/l)	7	16	6.9	7
Radium 226 (pCi/l)	8,9	0.9	N/A	0.0
Radium 228 (pCi/l)	8,9	<0.8U	N/A	<0.5U
Uranium	8,9	0.0020	N/A	0.0021
Radon (pCi/l)	13	100	90	89

F = field
L = lab

Table 17. Qualified Analytical Results CW-02-02-000523 (Fallon City Well #2)

ANALYTE	Bottle No.	AAL	SEM	SVL
Alkalinity Total	1	115	206	223
Alkalinity Bicarbonate	1	73	194	223
Alkalinity Carbonate	1	42	12	<1
Alkalinity Hydroxide	1	<1	<1	<1
pH	1	9.34	9.1	8.97
Turbidity	1	<0.4U	<0.1	<0.07U
Color-Apparent	1	<0-5UJ	<5	<5
TDS	2	544	524J	538
TSS	1	<2	1J	<0.1
Nitrate as N	1	0.4	0.4	0.37
Nitrite as N	1	<0.1	<0.5	<0.25
NO3 + NO2	3	<2	N/A	<0.02
Calcium	1	1.72	1.5	1.17
Magnesium	1	0.591	0.45	0.525
Potassium	1	10.7	7.1	8.3
Sodium	1	220	190	202
Chloride	1	86.4	85	87.1
Fluoride	1	0.6	<1	0.5
Silica	1	33	27	26.9
Sulfate	1	82.1	85	90.4
Aluminum	4	<0.02	<0.05	<0.024
Antimony	4	<0.003	< 0.002	<0.001
Arsenic	12	0.139	0.098	0.114
Arsenic	4	0.105J	0.11	0.096
Arsenic	5	0.132	0.099	0.099
Arsenic (+3F)	10	<0.005	< 0.002	<0.001
Arsenic (+5F)	11	0.108	0.097	0.11
Barium	4	<0.02	< 0.002	<0.002
Beryllium	4	<0.002	< 0.002	<0.002
Cadmium	4	<0.002	< 0.002	<0.0001
Chromium	4	<0.005	<0.001	<0.005
Chromium	5	<0.005	<0.001	<0.005
Silver	4	<0.01J	< 0.002	<0.006
Copper	4	<0.01	< 0.002	<0.003
Iron	4	<0.02	<0.05	<0.02
Lead	4	<0.007J	< 0.002	0.001
Manganese	4	<0.005	< 0.002	<0.002
Mercury	4	<0.0005	<0.0005	<0.0002
Nickel	4	<0.02	< 0.002	<0.023
Selenium	4	0.019	< 0.002	<0.001
Thallium	4	<0.001	< 0.001	<0.001
Zinc	4	<0.05	< 0.02	<0.003
Arsenic (+3L)	6	N/A	< 0.002	<0.002
Arsenic (+5L)	6	N/A	0.11	0.094
Phosphorus as P	1	N/A	N/A	0.22J
Ortho-Phosphate as P	1	N/A	N/A	N/A
Gross Alpha (pCi/l)	7	7	3.1	6
Gross Beta (pCi/l)	7	13	9.9	12
Radium 226 (pCi/l)	8,9	0.1	N/A	0.3
Radium 228 (pCi/l)	8,9	<0.9U	N/A	<1.4U
Uranium	8,9	0.0008	N/A	0.0024
Radon (pCi/l)	13	45	<50	64

F = field
L = lab

Table 18. Qualified Analytical Results CW-03-01-000525 (Fallon City Well #3)

ANALYTE	Bottle No.	AAL	SEM	SVL
Alkalinity Total	1	223	212	201
Alkalinity Bicarbonate	1	169	172	161
Alkalinity Carbonate	1	54	40	40
Alkalinity Hydroxide	1	<1	<1	<1
pH	1	9.51	9.22	9.07
Turbidity	1	<0.3U	< 0.1	<0.16U
Color-Apparent	1	<10-15U	< 5	<5J
TDS	2	508	526	533
TSS	1	<2	1	1.6
Nitrate as N	1	0.3	<0.3	0.37
Nitrite as N	1	<0.1	<0.5	<0.25
NO3 + NO2	3	<2	N/A	0.25
Calcium	1	1.38	1.3	1.45
Magnesium	1	0.583	0.4	0.46
Potassium	1	11	6.4	6.4
Sodium	1	226	190	184
Chloride	1	85.1	87	88.5
Fluoride	1	0.5	<1	0.5
Silica	1	34.4	27	26.5
Sulfate	1	81.6	88	89.8
Aluminum	4	<0.02	<0.05	<0.024
Antimony	4	<0.003	< 0.002	<0.001
Arsenic	12	0.0966	0.097	0.116
Arsenic	4	0.108J	0.1	0.11
Arsenic	5	0.0959	0.099	0.107
Arsenic (+3F)	10	<0.005	<0.002U	<0.001
Arsenic (+5F)	11	0.104	0.093	0.092
Barium	4	<0.02	< 0.002	<0.002
Beryllium	4	<0.002	< 0.002	<0.002
Cadmium	4	<0.002	< 0.002	<0.0001
Chromium	4	<0.005	0.003	<0.005
Chromium	5	<0.005	<0.001	<0.005
Silver	4	<0.01J	< 0.002	<0.006
Copper	4	<0.01	< 0.002	0.003
Iron	4	<0.02	<0.05	<0.02
Lead	4	<0.007J	< 0.002	<0.001
Manganese	4	<0.005	< 0.002	<0.002
Mercury	4	<0.0005	< 0.0005	<0.0002
Nickel	4	<0.02	0.002	<0.023
Selenium	4	<0.01	< 0.002	<0.001
Thallium	4	<0.001	< 0.001	<0.001
Zinc	4	<0.05	< 0.02	<0.003
Arsenic (+3L)	6	N/A	< 0.002	<0.002J
Arsenic (+5L)	6	N/A	0.12	0.102J
Phosphorus as P	1	N/A	N/A	0.23J
Ortho-Phosphate as P	1	N/A	N/A	N/A
Gross Alpha (pCi/l)	7	9	1.1	0
Gross Beta (pCi/l)	7	12	8.6	7
Radium 226 (pCi/l)	8,9	0	N/A	-0.1
Radium 228 (pCi/l)	8,9	<2.4U	N/A	<1.2U
Uranium	8,9	0.0020	N/A	0.0021
Radon (pCi/l)	13	81	96	120

F = field
L = lab

Table 19. Qualified Analytical Results CW-04-01-000526 (Fallon City Well #4)

ANALYTE	Bottle No.	AAL	SEM	SVL
Alkalinity Total	1	222	217	222
Alkalinity Bicarbonate	1	168	169	177
Alkalinity Carbonate	1	54	48	45.2
Alkalinity Hydroxide	1	<1	<1	<1
pH	1	9.5	9.31	9.08
Turbidity	1	<0.1U	< 0.1	<0.08U
Color-Apparent	1	<5-10U	< 5	<5J
TDS	2	548	532J	571
TSS	1	<2	<1	0.9
Nitrate as N	1	0.4	<0.3	0.4
Nitrite as N	1	<0.1	<0.5	<0.25
NO3 + NO2	3	<2	N/A	0.28
Calcium	1	1.4	1.3	<1.31U
Magnesium	1	0.654	0.46	0.515
Potassium	1	11.8	6.7	8
Sodium	1	240	190	189
Chloride	1	106	97	101
Fluoride	1	0.7	<1	0.5
Silica	1	15.7	26	23.8
Sulfate	1	89.1	90	93.2
Aluminum	4	<0.02	<0.05	<0.024
Antimony	4	<0.003	< 0.002	<0.001
Arsenic	12	0.0993	0.11	0.094
Arsenic	4	0.13J	0.10	0.099
Arsenic	5	0.103	0.10	0.102
Arsenic (+3F)	10	<0.005	<0.002U	<0.001
Arsenic (+5F)	11	0.11	0.095	0.107
Barium	4	<0.02	< 0.002	0.003
Beryllium	4	<0.002	< 0.002	<0.002
Cadmium	4	<0.002	< 0.002	<0.0001
Chromium	4	<0.005	0.002	<0.005
Chromium	5	<0.005	<0.001	<0.005
Silver	4	<0.01J	< 0.002	<0.006
Copper	4	<0.01	< 0.002	0.007
Iron	4	<0.02	<0.05	<0.02
Lead	4	<0.007J	< 0.002	<0.001
Manganese	4	<0.005	< 0.002	<0.002
Mercury	4	<0.0005	< 0.0005	<0.0002
Nickel	4	<0.02	< 0.002	<0.023
Selenium	4	<0.01	< 0.002	<0.001
Thallium	4	<0.001	< 0.001	<0.001
Zinc	4	<0.05	< 0.02	0.003
Arsenic (+3L)	6	N/A	< 0.002J	<0.002J
Arsenic (+5L)	6	N/A	0.12J	0.101J
Phosphorus as P	1	N/A	0.2	0.22J
Ortho-Phosphate as P	1	0.83UJ	N/A	N/A
Gross Alpha (pCi/l)	7	9	6.1	4
Gross Beta (pCi/l)	7	12	5.1	7
Radium 226 (pCi/l)	8,9	0.1	<0.5	0.1
Radium 228 (pCi/l)	8,9	<1.3U	N/A	<1.3U
Uranium	8,9	0.0021	N/A	0.0022
Radon (pCi/l)	13	81	88	120

F = field
L = lab

Table 20. Qualified Analytical Results NW-01-01-000524 (Naval Well #1)

Analyte	Bottle #	AAL	SEM	SVL
Alkalinity Total	1	246	226	221
Alkalinity Bicarbonate	1	184	182	178
Alkalinity Carbonate	1	62	44	42.3
Alkalinity Hydroxide	1	<1	<1	<1
pH	1	9.45	9.35	9.04
Turbidity	1	<0.1U	<0.1	0.42
Color-Apparent	1	<0-5U	<5	<5
TDS	2	612	578	581
TSS	1	<2	1	0.5
Nitrate as N	1	0.5	<0.3	0.5
Nitrite as N	1	<0.1	<0.5	<0.25
NO3 + NO2	3	<2	N/A	0.3
Calcium	1	1.1	1.1	1.25
Magnesium	1	0.56	0.44	0.452
Potassium	1	12.6	7.4	7.4
Sodium	1	270	220	215
Chloride	1	102	110	115
Fluoride	1	0.8	<1	0.5
Silica	1	30	24	24
Sulfate	1	91.4	94	100
Aluminum	4	<0.02	<0.05	<0.024
Antimony	4	0.019	< 0.002	<0.001
Arsenic	12	0.124	0.12	0.09
Arsenic	4	0.146J	0.12	0.119
Arsenic	5	0.117	0.11	0.126
Arsenic (+3F)	10	<0.005	< 0.002	<0.001
Arsenic (+5F)	11	0.117	0.099	0.114
Barium	4	<0.02	< 0.002	<0.002
Beryllium	4	<0.002	< 0.002	<0.002
Cadmium	4	<0.002	< 0.002	<0.0001
Chromium	4	<0.005	0.003	<0.005
Chromium	5	<0.005	<0.001	<0.005
Silver	4	<0.01J	< 0.002	<0.006
Copper	4	<0.01	< 0.002	0.007
Iron	4	<0.02	<0.05	<0.02U
Lead	4	<0.007J	< 0.002	<0.001
Manganese	4	<0.005	< 0.002	<0.002
Mercury	4	<0.0005	<0.0005	<0.0002
Nickel	4	<0.02	< 0.002	<0.023
Selenium	4	<0.01	< 0.002	<0.001
Thallium	4	<0.001	< 0.001	<0.001
Zinc	4	<0.05	< 0.02	0.009
Arsenic (+3L)	6	N/A	< 0.002	<0.002
Arsenic (+5L)	6	N/A	0.13	0.104
Phosphorus as P	1	N/A	N/A	0.24J
Ortho-Phosphate as P	1	N/A	N/A	N/A
Gross Alpha (pCi/l)	7	5	3	7
Gross Beta (pCi/l)	7	7	8.1	12
Radium 226 (pCi/l)	8,9	0	N/A	0.2
Radium 228 (pCi/l)	8,9	<0.6U	N/A	<0.9U
Uranium	8,9	0.0018	N/A	0.0019
Radon (pCi/l)	13	150	93	130

F = field
L = lab

Table 21. Qualified Analytical Results NW-03-01-000524 (Naval Well #3)

ANALYTE	Bottle No.	AAL	SEM	SVL
Alkalinity Total	1	247	230	220
Alkalinity Bicarbonate	1	183	182	178
Alkalinity Carbonate	1	64	48	41.2
Alkalinity Hydroxide	1	<1	<1	<1
pH	1	9.43	9.34	8.96
Turbidity	1	<0.1U	<0.1	0.47
Color-Apparent	1	<5-10U	<5	<5
TDS	2	608	615	585
TSS	1	<2	1	<0.1
Nitrate as N	1	0.5	<0.3	0.49
Nitrite as N	1	<0.1	<0.5	<0.25
NO3 + NO2	3	<2	N/A	0.25
Calcium	1	0.92	1.1	1.29
Magnesium	1	0.55	0.44	0.51
Potassium	1	11.8	6.9	7.3
Sodium	1	268	210	219
Chloride	1	103	110	118
Fluoride	1	0.7	<1	0.6
Silica	1	33.6	24	24.3
Sulfate	1	92.8	95	102
Aluminum	4	<0.02	<0.05	<0.024
Antimony	4	0.006	< 0.002	<0.001
Arsenic	12	0.125	0.12	0.123
Arsenic	4	0.118J	0.12	0.122
Arsenic	5	0.118	0.11	0.108
Arsenic (+3F)	10	<0.005	< 0.002	<0.001
Arsenic (+5F)	11	0.118	0.099	0.108
Barium	4	<0.02	< 0.002	<0.002
Beryllium	4	<0.002	< 0.002	<0.002
Cadmium	4	<0.002	< 0.002	<0.0001
Chromium	4	<0.005	<0.001	<0.005
Chromium	5	<0.005	<0.001	<0.005
Silver	4	<0.01J	< 0.002	<0.006
Copper	4	<0.01	0.006	<0.003
Iron	4	<0.02	<0.05	<0.02
Lead	4	<0.007J	< 0.002	<0.001
Manganese	4	<0.005	< 0.002	<0.002
Mercury	4	<0.0005	<0.0005	<0.0002
Nickel	4	<0.02	< 0.002	<0.023
Selenium	4	<0.01	< 0.002	<0.001
Thallium	4	<0.001	< 0.001	<0.001
Zinc	4	<0.05	< 0.02	<0.003
Arsenic (+3L)	6	N/A	< 0.002	<0.002
Arsenic (+5L)	6	N/A	0.13	0.1
Phosphorus as P	1	N/A	N/A	0.23J
Ortho-Phosphate as P	1	N/A	N/A	N/A
Gross Alpha (pCi/l)	7	5	1.4	4
Gross Beta (pCi/l)	7	9	6.4	17
Radium 226 (pCi/l)	8,9	0	N/A	0.2
Radium 228 (pCi/l)	8,9	<0.5U	N/A	<0.6U
Uranium	8,9	0.0020	N/A	0.0018
Radon (pCi/l)	13	110	87	110

F = field
L = lab

Table 22. Qualified Analytical Results CW-04-03-000526 (Field Blank)

ANALYTE	Bottle No.	AAL	SEM	SVL
Alkalinity Total	1	<1	2	<1
Alkalinity Bicarbonate	1	<1	2	<1
Alkalinity Carbonate	1	<1	<1	<1
Alkalinity Hydroxide	1	<1	<1	<1
pH	1	6.04	5.58	5.95
Turbidity	1	<0.1	< 0.1	0.11
Color-Apparent	1	5-10	< 5	<5J
TDS	2	<10	<7J	<10
TSS	1	<2	<1	<0.1
Nitrate as N	1	<0.1	<0.1	<0.05
Nitrite as N	1	<0.1	<0.1	<0.05
NO3 + NO2	3	<2	N/A	<0.02
Calcium	1	<0.5	<0.1	0.062
Magnesium	1	<0.1	<0.1	0.048
Potassium	1	<0.1	<0.5	<1.7
Sodium	1	<0.5	2.7	<0.088
Chloride	1	6.8	<0.1	<0.2
Fluoride	1	<0.1	<0.1	<0.1
Silica	1	0.109	<1	<0.17
Sulfate	1	5.9	<0.1	<0.3
Aluminum	4	<0.02	<0.05	<0.024
Antimony	4	<0.003	< 0.002	<0.001
Arsenic	12	<0.005	< 0.002	<0.001
Arsenic	4	<0.005J	< 0.002	<0.001
Arsenic	5	<0.005	< 0.002	<0.001
Arsenic (+3F)	10	<0.005	0.003	<0.001
Arsenic (+5F)	11	<0.005	< 0.002	<0.001
Barium	4	<0.02	< 0.002	<0.002
Beryllium	4	<0.002	< 0.002	<0.002
Cadmium	4	<0.002	< 0.002	<0.0001
Chromium	4	<0.005	<0.001	<0.005
Chromium	5	<0.005	<0.001	<0.005
Silver	4	<0.01J	< 0.002	<0.006
Copper	4	<0.01	< 0.002	<0.003
Iron	4	<0.02	<0.05	<0.02
Lead	4	<0.007J	< 0.002	<0.001
Manganese	4	<0.005	< 0.002	<0.002
Mercury	4	<0.0005	< 0.0005	<0.0002
Nickel	4	<0.02	< 0.002	<0.023
Selenium	4	<0.01	< 0.002	<0.001
Thallium	4	<0.001	< 0.001	<0.001
Zinc	4	<0.05	< 0.02	<0.003
Arsenic (+3L)	6	N/A	< 0.002J	<0.002J
Arsenic (+5L)	6	N/A	< 0.002J	<0.002J
Phosphorus as P	1	N/A	<0.02	<0.01J
Ortho-Phosphate as P	1	<0.25J	N/A	N/A
Gross Alpha (pCi/l)	7	1	<1.0	1
Gross Beta (pCi/l)	7	1	<1.2	1
Radium 226 (pCi/l)	8,9	0.1	N/A	0.1
Radium 228 (pCi/l)	8,9	<0.07U	N/A	<0.7U
Uranium	8,9	<0.0001	N/A	<0.0001
Radon (pCi/l)	13	N/A	N/A	N/A

F = field
L = lab

Table 23. Eh Calculations

Sample Location	Date	Sample		Zobell Solution			Corrected Sample EMF relative to reference electrode (mv)	EMF of reference electrode relative to the standard hydrogen electrode EMF (mv)	Sample Eh (relative to the standard hydrogen electrode) Eh (mv)
		Measured potential relative to reference electrode EMF (mv)	Temp (deg C)	Measured potential relative to reference electrode EMF (mv)	Temp (deg C)	Theoretical potential relative to reference electrode EMF (mv)			
CW-01	5/25/00	265	19.6	231	22.8	238	272	202	474
CW-03	5/25/00	111	20.5	231	22.8	237	117	201	318
CW-04	5/26/00	141	20	228	22.7	238	151	202	352
CW-02	5/23/00	85	20.4	225	24	237	97	201	298
NW-01	5/24/00	-5	20.9	230	21.7	236	1	201	202
NW-03	5/24/00	25	22.7	230	21.7	234	29	199	228

Note: No temperature correction was applied to the Zobell measurement. The resulting error in Eh is considered negligible and is calculated to be less than a maximum of 2%

APPENDIX A

ORIGINAL (UNQUALIFIED) LABORATORY ANALYSIS

DRAFT

Sierra Environmental Monitoring, Inc.

Laboratory Analysis Report

City of Fallon
55 West Williams Ave
Fallon, NV 89406
Attn: Paul Strasdin

Date:	7/28/00
Client:	FAL-017
Taken by:	T.Runnells-Shep
Report:	35162
PO #:	35250

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1209	CW-01-01-000525 - #1,2,3,4,7,8,9,13	5/25/00		5/25/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Alkalinity, Total	EPA 310.1	212	mg/L CaCO3		Tretten	5/26/00
Alkalinity/Bicarbonate	EPA 310.1	168	mg/L CaCO3		Tretten	5/26/00
Alkalinity/Carbonate	EPA 310.1	44	mg/L CaCO3		Tretten	5/26/00
Alkalinity/Hydroxide	EPA 310.1	<1	mg/L CaCO3		Tretten	5/26/00
pH	EPA 150.1	9.28	pH Units	6.5 to 8.5	Tretten	5/26/00
Turbidity	EPA 180.1	< 0.1	NTU		Kobza	5/26/00
Color Apparent	EPA 110.2	< 5	Color Units	15	Kobza	5/26/00
Total Dissolved Solids	EPA 160.1	520	mg/L	500/1000 mg/L	Rivera	5/26/00
Suspended Solids	EPA 160.2	<1	mg/L		Rivera	5/26/00
Nitrate-N - Ion Chromatography	EPA 300.0	<0.3N	mg/L	10 mg/L as N	Lowe	5/26/00
Nitrite-N - Ion Chromatography	EPA 300.0	<0.5N	mg/L	1 mg/L as N	Lowe	5/26/00
NO3 – NO2	EPA 300.0	<0.8N	mg/L		Lowe	5/26/00
Calcium - ICP-OES	EPA 200.7	1.3	mg/L		Jones	6/1/00
Magnesium - ICP-OES	EPA 200.7	0.42	mg/L	125 mg/L	Jones	6/1/00
Potassium - ICP-OES	EPA 200.7	6.8	mg/L		Jones	6/1/00
Sodium - ICP-OES	EPA 200.7	210	mg/L		Jones	6/1/00
Chloride - Ion Chromatography	EPA 300.0	91	mg/L	250 mg/L	Lowe	5/26/00
Fluoride - Ion Chromatography	EPA 300.0	<1	mg/L	2.0/4.0 mg/L	Lowe	5/26/00
Silica	EPA 370.1	28	mg/L		Tretten	5/31/00
Sulfate - Ion Chromatography	EPA 300.0	86	mg/L	500 mg/L	Lowe	5/26/00
Antimony - ICP-MS	EPA 200.8	< 0.002	mg/L	0.006 mg/L	Lambert	6/9/00
Aluminum - ICP-OES	EPA 200.7	<0.05	mg/L	0.05 to 0.2 mg/L	Faulstich	6/2/00
Arsenic - ICP-MS	EPA 200.8	0.1	mg/L	0.05 mg/L	Lambert	6/5/00
Barium - ICP-MS	EPA 200.8	< 0.002	mg/L	2.0 mg/L	Lambert	6/9/00
Beryllium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.004 mg/L	Lambert	6/9/00
Cadmium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.005 mg/L	Lambert	6/9/00
Chromium - ICP-MS	EPA 200.8	0.007	mg/L	0.1 mg/L	Lambert	6/9/00
Silver - ICP-MS	EPA 200.8	< 0.002	mg/L	0.1 mg/L	Lambert	6/9/00
Copper - ICP-MS	EPA 200.8	< 0.002	mg/L	1.0 mg/L	Lambert	6/9/00
Iron - ICP-OES	EPA 200.7	<0.05	mg/L	0.3 mg/L	Faulstich	6/2/00
Lead - ICP-MS	EPA 200.8	< 0.002	mg/L	0.015 mg/L	Lambert	6/9/00
Manganese - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	6/9/00

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President

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John C. Seher
Managers

Sierra Environmental Monitoring, Inc.

Laboratory Analysis Report

City of Fallon
55 West Williams Ave
Fallon, NV 89406
Attn: Paul Strasdin

Date:	7/28/00
Client:	FAL-017
Taken by:	T.Runnells-Shep
Report:	35162
PO #:	35250

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1209	CW-01-01-000525 - #1,2,3,4,7,8,9,13	5/25/00		5/25/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Mercury - AA Cold Vapor	EPA 245.1	< 0.0005	mg/L	0.002 mg/L	Kobza	6/7/00
Nickel - ICP-MS	EPA 200.8	< 0.002	mg/L	0.1 mg/L	Lambert	6/9/00
Selenium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	6/9/00
Thallium - ICP-MS	EPA 200.8	< 0.001	mg/L	0.002 mg/L	Lambert	6/9/00
Zinc - ICP-MS	EPA 200.8	< 0.02	mg/L	5 mg/L	Lambert	6/9/00
R[illegible]	Subcontract	See Report				6/26/00
[illegible] Alpha and Beta Radiologic	Subcontract	See Report				6/21/00
Radium 226 - Radiological	Subcontract	See Report				7/28/00

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1210	CW-01-01-000525 - #12	5/25/00		5/25/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.1	mg/L	0.05 mg/L	Lambert	6/5/00

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1211	CW-01-01-000525 - #5	5/25/00		5/25/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.1	mg/L	0.05 mg/L	Lambert	6/5/00
Chromium - ICP-MS	EPA 200.8	0.007	mg/L	0.1 mg/L	Lambert	6/9/00

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1212	CW-01-01-000525 - #11	5/25/00		5/25/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.093	mg/L	0.05 mg/L	Lambert	6/5/00

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Laboratory Analysis Report

City of Fallon
55 West Williams Ave
Fallon, NV 89406
Attn: Paul Strasdin

Date: 7/28/00
Client: FAL-017
Taken by: T.Runnells-Shep
Report: 35162
PO #: 35250

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1213	CW-01-01-000525 - #10	5/25/00		5/25/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.002	mg/L	0.05 mg/L	Lambert	6/5/00

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1214	CW-01-01-000525 - #6	5/25/00		5/25/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic Trivalent - ICP-MS	EPA 200.8	< 0.002	mg/L		Lambert	6/8/00
Arsenic Pentivalent - ICP-MS	EPA 200.8	0.11	mg/L		Lambert	6/8/00
Arsenic - ICP-MS	EPA 200.8	0.095	mg/L	0.05 mg/L	Lambert	6/5/00
Arsenic Speciation	Ficklin 1983	Completed			Tretten	5/26/00

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Laboratory Analysis Report

City of Fallon
55 West Williams Ave
Fallon, NV 89406
Attn: Paul Strasdin

Date: 7/28/00
Client: FAL-017
Taken by: T.Runnells-Shep
Report: 35162
PO #: 35250

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1215	CW-01-02-000525 - #1,2,3,4,7,8,9,13	5/25/00		5/25/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Alkalinity, Total	EPA 310.1	214	mg/L CaCO3		Tretten	5/26/00
Alkalinity/Bicarbonate	EPA 310.1	166	mg/L CaCO3		Tretten	5/26/00
Alkalinity/Carbonate	EPA 310.1	48	mg/L CaCO3		Tretten	5/26/00
Alkalinity/Hydroxide	EPA 310.1	<1	mg/L CaCO3		Tretten	5/26/00
pH	EPA 150.1	9.25	pH Units	6.5 to 8.5	Tretten	5/26/00
[illegible]idity	EPA 180.1	< 0.1	NTU		Kobza	5/26/00
[illegible] Apparent	EPA 110.2	< 5	Color Units	15	Kobza	5/26/00
Total Dissolved Solids	EPA 160.1	516	mg/L	500/1000 mg/L	Rivera	5/26/00
Suspended Solids	EPA 160.2	2	mg/L		Rivera	5/26/00
Nitrate-N - Ion Chromatography	EPA 300.0	<0.3N	mg/L	10 mg/L as N	Lowe	5/26/00
Nitrite-N - Ion Chromatography	EPA 300.0	<0.5N	mg/L	1 mg/L as N	Lowe	5/26/00
NO3 + NO2	EPA 300.0	<0.8N	mg/L		Lowe	5/26/00
Calcium - ICP-OES	EPA 200.7	1.3	mg/L		Jones	6/1/00
Magnesium - ICP-OES	EPA 200.7	0.43	mg/L	125 mg/L	Jones	6/1/00
Potassium - ICP-OES	EPA 200.7	6.8	mg/L		Jones	6/1/00
Sodium - ICP-OES	EPA 200.7	190	mg/L		Jones	6/1/00
Chloride - Ion Chromatography	EPA 300.0	92	mg/L	250 mg/L	Lowe	5/26/00
Fluoride - Ion Chromatography	EPA 300.0	<1	mg/L	2.0/4.0 mg/L	Lowe	5/26/00
Silica	EPA 370.1	28	mg/L		Tretten	5/31/00
Sulfate - Ion Chromatography	EPA 300.0	87	mg/L	500 mg/L	Lowe	5/26/00
Antimony - ICP-MS	EPA 200.8	< 0.002	mg/L	0.006 mg/L	Lambert	6/9/00
Aluminum - ICP-OES	EPA 200.7	<0.05	mg/L	0.05 to 0.2 mg/L	Faulstich	6/2/00
Arsenic - ICP-MS	EPA 200.8	0.1	mg/L	0.05 mg/L	Lambert	6/5/00
Barium - ICP-MS	EPA 200.8	< 0.002	mg/L	2.0 mg/L	Lambert	6/9/00
Beryllium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.004 mg/L	Lambert	6/9/00
Cadmium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.005 mg/L	Lambert	6/9/00
Chromium - ICP-MS	EPA 200.8	0.01	mg/L	0.1 mg/L	Lambert	6/9/00
Silver - ICP-MS	EPA 200.8	< 0.002	mg/L	0.1 mg/L	Lambert	6/9/00
Copper - ICP-MS	EPA 200.8	< 0.002	mg/L	1.0 mg/L	Lambert	6/9/00
Iron - ICP-OES	EPA 200.7	<0.05	mg/L	0.3 mg/L	Faulstich	6/2/00
[illegible] - ICP-MS	EPA 200.8	< 0.002	mg/L	0.015 mg/L	Lambert	6/9/00
[illegible]anese - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	6/9/00

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William F. Pillsbury
President

John Kobza, Ph.D.
John C. Seher
Managers

Laboratory Analysis Report

Sierra Environmental Monitoring, Inc.

City of Fallon
55 West Williams Ave
Fallon, NV 89406
Attn: Paul Strasdin

Date:	7/28/00
Client:	FAL-017
Taken by:	T.Runnells-Shep
Report:	35162
PO #:	35250

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1215	CW-01-02-000525 - #1,2,3,4,7,8,9,13	5/25/00		5/25/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Mercury - AA Cold Vapor	EPA 245.1	< 0.0005	mg/L	0.002 mg/L	Kobza	6/7/00
Nickel - ICP-MS	EPA 200.8	< 0.002	mg/L	0.1 mg/L	Lambert	6/9/00
Selenium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	6/9/00
Thallium - ICP-MS	EPA 200.8	< 0.001	mg/L	0.002 mg/L	Lambert	6/9/00
Zinc - ICP-MS	EPA 200.8	< 0.02	mg/L	5 mg/L	Lambert	6/9/00
T n	Subcontract	See Report				6/26/00
Alpha and Beta Radiologic	Subcontract	See Report				6/21/00

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1216	CW-01-02-000525 - #12	5/25/00		5/25/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.095	mg/L	0.05 mg/L	Lambert	6/5/00

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1217	CW-01-02-000525 - #5	5/25/00		5/25/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.1	mg/L	0.05 mg/L	Lambert	6/5/00
Chromium - ICP-MS	EPA 200.8	0.008	mg/L	0.1 mg/L	Lambert	6/9/00

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1218	CW-01-02-000525 - #11	5/25/00		5/25/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.096	mg/L	0.05 mg/L	Lambert	6/5/00

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Sierra Environmental Monitoring, Inc.

Laboratory Analysis Report

City of Fallon
55 West Williams Ave
Fallon, NV 89406
Attn: Paul Strasdin

Date: 7/28/00
Client: FAL-017
Taken by: T.Runnells-Shep
Report: 35162
PO #: 35250

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1219	CW-01-02-000525 - #10	5/25/00		5/25/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.003	mg/L	0.05 mg/L	Lambert	6/5/00

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1220	CW-01-02-000525 - #6	5/25/00		5/25/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic Trivalent - ICP-MS	EPA 200.8	< 0.002	mg/L		Lambert	6/8/00
Arsenic Pentivalent - ICP-MS	EPA 200.8	0.11	mg/L		Lambert	6/8/00
Arsenic - ICP-MS	EPA 200.8	0.094	mg/L	0.05 mg/L	Lambert	6/5/00
Arsenic Speciation	Ficklin 1983	Completed			Tretten	5/26/00

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Laboratory Analysis Report

Sierra Environmental Monitoring, Inc.

City of Fallon
55 West Williams Ave
Fallon, NV 89406

Date: 06/22/2000
Client: FAL-017
Taken by: T.Runnells-Shep
Report: 35121
PO #:

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1066	CW-02-01-000523-#1,2,3,4,7,8,9,13	05/23/2000	9:30 AM	05/23/2000

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Alkalinity, Total	EPA 310.1	206	mg/L CaCO3		Tretten	05/26/2000
Alkalinity/Bicarbonate	EPA 310.1	194	mg/L CaCO3		Tretten	05/26/2000
Alkalinity/Carbonate	EPA 310.1	12	mg/L CaCO3		Tretten	05/26/2000
Alkalinity/Hydroxide	EPA 310.1	<1	mg/L CaCO3		Tretten	05/26/2000
pH	EPA 150.1	9.1	pH Units	6.5 to 8.5	Tretten	05/25/2000
Turbidity	EPA 180.1	<0.1	NTU		Kobza	05/25/2000
Color, Apparent	EPA 110.2	<5	Color Units	15	Kobza	05/25/2000
Total Dissolved Solids	EPA 160.1	524	mg/L	500/1000 mg/L	Rivera	05/31/2000
Suspended Solids	EPA 160.2	1	mg/L		Rivera	05/31/2000
Nitrate-N - Ion Chromatography	EPA 300.0	0.4N	mg/L	10 mg/L as N	Lowe	05/24/2000
Nitrite-N - Ion Chromatography	EPA 300.0	<0.5N	mg/L	1 mg/L as N	Lowe	05/24/2000
NO3 + NO2	EPA 300.0	<0.9N	mg/L		Lowe	05/24/2000
Calcium - ICP-OES	EPA 200.7	1.5	mg/L		Faulstich	05/26/2000
Magnesium - ICP-OES	EPA 200.7	0.45	mg/L	125 mg/L	Faulstich	05/26/2000
Potassium - ICP-OES	EPA 200.7	7.1	mg/L		Faulstich	05/26/2000
Sodium - ICP-OES	EPA 200.7	190	mg/L		Faulstich	05/26/2000
Chloride - Ion Chromatography	EPA 300.0	85	mg/L	250 mg/L	Lowe	05/24/2000
Fluoride - Ion Chromatography	EPA 300.0	<1	mg/L	2.0/4.0 mg/L	Lowe	05/24/2000
Silica	EPA 370.1	27	mg/L		Tretten	05/31/2000
Sulfate - Ion Chromatography	EPA 300.0	85	mg/L	500 mg/L	Lowe	05/24/2000
Antimony - ICP-MS	EPA 200.8	< 0.002	mg/L	0.006 mg/L	Lambert	06/02/2000
Aluminum - ICP-OES	EPA 200.7	<0.05	mg/L	0.05 to 0.2 mg/L	Faulstich	05/30/2000
Arsenic - ICP-MS	EPA 200.8	0.11	mg/L	0.05 mg/L	Lambert	06/02/2000
Barium - ICP-MS	EPA 200.8	< 0.002	mg/L	2.0 mg/L	Lambert	06/02/2000
Beryllium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.004 mg/L	Lambert	06/02/2000
Cadmium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.005 mg/L	Lambert	06/02/2000
Chromium - ICP-MS	EPA 200.8	0.006	mg/L	0.1 mg/L	Lambert	06/02/2000
Silver - ICP-MS	EPA 200.8	< 0.002	mg/L	0.1 mg/L	Lambert	06/02/2000
Copper - ICP-MS	EPA 200.8	< 0.002	mg/L	1.0 mg/L	Lambert	06/02/2000
Iron - ICP-OES	EPA 200.7	<0.05	mg/L	0.3 mg/L	Faulstich	05/30/2000
Lead - ICP-MS	EPA 200.8	< 0.002	mg/L	0.015 mg/L	Lambert	06/02/2000
Manganese - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	06/02/2000

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Managers

Laboratory Analysis Report

Sierra Environmental Monitoring, Inc.

City of Fallon
55 West Williams Ave
Fallon, NV 89406

Date: 06/22/2000
Client: FAL-017
Taken by: T.Runnells-Shep
Report: 35121
PO #:

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1066	CW-02-01-000523-#1,2,3,4,7,8,9,13	05/23/2000	9:30 AM	05/23/2000

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Mercury - AA Cold Vapor	EPA 245.1	<0.0005	mg/L	0.002 mg/L	Jones	05/26/2000
Nickel - ICP-MS	EPA 200.8	< 0.002	mg/L	0.1 mg/L	Lambert	06/02/2000
Selenium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	06/02/2000
Thallium - ICP-MS	EPA 200.8	< 0.001	mg/L	0.002 mg/L	Lambert	06/02/2000
Zinc - ICP-MS	EPA 200.8	< 0.02	mg/L	5 mg/L	Lambert	06/02/2000
Ra[illegible]	Subcontract	See Report				06/12/2000
Gr[illegible]lpha and Beta Radiologic	Subcontract	See Report				06/21/2000

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1084	CW-02-01-000523-#12	05/23/2000	9:30 AM	05/23/2000

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.098	mg/L	0.05 mg/L	Lambert	06/05/2000

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1085	CW-02-01-000523-#5	05/23/2000	9:30 AM	05/23/2000

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.099	mg/L	0.05 mg/L	Lambert	06/05/2000
Chromium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.1 mg/L	Lambert	06/09/2000

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1086	CW-02-01-000523-#11	05/23/2000	9:30 AM	05/23/2000

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.097	mg/L	0.05 mg/L	Lambert	06/05/2000

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Laboratory Analysis Report

Sierra Environmental Monitoring, Inc.

City of Fallon
55 West Williams Ave
Fallon, NV 89406

Date: 06/22/2000
Client: FAL-017
Taken by: T.Runnells-Shep
Report: 35121
PO #:

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1087	CW-02-01-000523-#10	05/23/2000	9:30 AM	05/23/2000

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	06/05/2000

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1088	CW-02-01-000523-#6	05/23/2000	9:30 AM	05/23/2000

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic Trivalent - ICP-MS	EPA 200.8	< 0.002	mg/L		Lambert	06/08/2000
Arsenic Pentivalent - ICP-MS	EPA 200.8	0.11	mg/L		Lambert	06/08/2000
Arsenic - ICP-MS	EPA 200.8	0.099	mg/L	0.05 mg/L	Lambert	06/05/2000
Arsenic Speciation	Ficklin 1983	Completed			Tretten	05/25/2000

SAMPLE WATER AS TESTED ____ DID X DID NOT MEET DRINKING WATER STANDARDS. As, Pb

Approved By: _____ **Date:** 6-22-00
Sierra Environmental Monitoring, Inc

This report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report is for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

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Laboratory Analysis Report

City of Fallon
55 West Williams Ave
Fallon, NV 89406
Attn: Paul Strasdin

Date: 7/28/00
Client: FAL-017
Taken by: T.Runnells-Shep
Report: 35162
PO #: 35250

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1221	CW-03-01-000525 - #1,2,3,4,7,8,9,13	5/25/00		5/25/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Alkalinity, Total	EPA 310.1	212	mg/L CaCO3		Tretten	5/26/00
Alkalinity/Bicarbonate	EPA 310.1	172	mg/L CaCO3		Tretten	5/26/00
Alkalinity/Carbonate	EPA 310.1	40	mg/L CaCO3		Tretten	5/26/00
Alkalinity/Hydroxide	EPA 310.1	<1	mg/L CaCO3		Tretten	5/26/00
pH	EPA 150.1	9.22	pH Units	6.5 to 8.5	Tretten	5/26/00
·idity	EPA 180.1	< 0.1	NTU		Kobza	5/26/00
...or Apparent	EPA 110.2	< 5	Color Units	15	Kobza	5/26/00
Total Dissolved Solids	EPA 160.1	526	mg/L	500/1000 mg/L	Rivera	5/26/00
Suspended Solids	EPA 160.2	1	mg/L		Rivera	5/26/00
Nitrate-N - Ion Chromatography	EPA 300.0	<0.3N	mg/L	10 mg/L as N	Lowe	5/26/00
Nitrite-N - Ion Chromatography	EPA 300.0	<0.5N	mg/L	1 mg/L as N	Lowe	5/26/00
NO3 - NO2	EPA 300.0	<0.8N	mg/L		Lowe	5/26/00
Calcium - ICP-OES	EPA 200.7	1.3	mg/L		Jones	6/1/00
Magnesium - ICP-OES	EPA 200.7	0.4	mg/L	125 mg/L	Jones	6/1/00
Potassium - ICP-OES	EPA 200.7	6.4	mg/L		Jones	6/1/00
Sodium - ICP-OES	EPA 200.7	190	mg/L		Jones	6/1/00
Chloride - Ion Chromatography	EPA 300.0	87	mg/L	250 mg/L	Lowe	5/26/00
Fluoride - Ion Chromatography	EPA 300.0	<1	mg/L	2.0/4.0 mg/L	Lowe	5/26/00
Silica	EPA 370.1	27	mg/L		Tretten	5/31/00
Sulfate - Ion Chromatography	EPA 300.0	88	mg/L	500 mg/L	Lowe	5/26/00
Antimony - ICP-MS	EPA 200.8	< 0.002	mg/L	0.006 mg/L	Lambert	6/9/00
Aluminum - ICP-OES	EPA 200.7	<0.05	mg/L	0.05 to 0.2 mg/L	Faulstich	6/2/00
Arsenic - ICP-MS	EPA 200.8	0.1	mg/L	0.05 mg/L	Lambert	6/5/00
Barium - ICP-MS	EPA 200.8	< 0.002	mg/L	2.0 mg/L	Lambert	6/9/00
Beryllium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.004 mg/L	Lambert	6/9/00
Cadmium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.005 mg/L	Lambert	6/9/00
Chromium - ICP-MS	EPA 200.8	0.008	mg/L	0.1 mg/L	Lambert	6/9/00
Silver - ICP-MS	EPA 200.8	< 0.002	mg/L	0.1 mg/L	Lambert	6/9/00
Copper - ICP-MS	EPA 200.8	< 0.002	mg/L	1.0 mg/L	Lambert	6/9/00
Iron - ICP-OES	EPA 200.7	<0.05	mg/L	0.3 mg/L	Faulstich	6/2/00
...d - ICP-MS	EPA 200.8	< 0.002	mg/L	0.015 mg/L	Lambert	6/9/00
...ganese - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	6/9/00

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Sierra Environmental Monitoring, Inc.

Laboratory Analysis Report

City of Fallon
55 West Williams Ave
Fallon, NV 89406
Attn: Paul Strasdin

Date:	7/28/00
Client:	FAL-017
Taken by:	T.Runnells-Shep
Report:	35162
PO #:	35250

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1221	CW-03-01-000525 - #1,2,3,4,7,8,9,13	5/25/00		5/25/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Mercury - AA Cold Vapor	EPA 245.1	< 0.0005	mg/L	0.002 mg/L	Kobza	6/7/00
Nickel - ICP-MS	EPA 200.8	0.002	mg/L	0.1 mg/L	Lambert	6/9/00
Selenium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	6/9/00
Thallium - ICP-MS	EPA 200.8	< 0.001	mg/L	0.002 mg/L	Lambert	6/9/00
Zinc - ICP-MS	EPA 200.8	< 0.02	mg/L	5 mg/L	Lambert	6/9/00
on	Subcontract	See Report				6/26/00
Gross Alpha and Beta Radiologic	Subcontract	See Report				6/21/00

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1222	CW-003-01000525 - #12	5/25/00		5/25/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.097	mg/L	0.05 mg/L	Lambert	6/5/00

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1223	CW-03-01-000525 - #5	5/25/00		5/25/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.099	mg/L	0.05 mg/L	Lambert	6/5/00
Chromium - ICP-MS	EPA 200.8	0.008	mg/L	0.1 mg/L	Lambert	6/9/00

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1224	CW-03-01-000525 - #11	5/25/00		5/25/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.093	mg/L	0.05 mg/L	Lambert	6/5/00

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Laboratory Analysis Report

City of Fallon
55 West Williams Ave
Fallon, NV 89406
Attn: Paul Strasdin

Date: 7/28/00
Client: FAL-017
Taken by: T.Runnells-Shep
Report: 35162
PO #: 35250

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1225	CW-03-01-000525 - #10	5/25/00		5/25/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.002	mg/L	0.05 mg/L	Lambert	6/5/00

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1226	CW-03-01-000525 - #6	5/25/00		5/25/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic Trivalent - ICP-MS	EPA 200.8	< 0.002	mg/L		Lambert	6/8/00
Arsenic Pentivalent - ICP-MS	EPA 200.8	0.12	mg/L		Lambert	6/8/00
Arsenic - ICP-MS	EPA 200.8	0.095	mg/L	0.05 mg/L	Lambert	6/5/00
Arsenic Speciation	Ficklin 1983	Completed			Tretten	5/26/00

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1227	CW-04-01-000525 - #13	5/25/00		5/25/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Radon	Subcontract	See Report				6/26/00

SAMPLE WATER AS TESTED ____ DID ____ DID NOT MEET DRINKING WATER STANDARDS.

Approved By: _____ Date: 7-28-00
Sierra Environmental Monitoring, Inc

This report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report is for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

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William F. Pillsbury
President

John Kobza, Ph.D.
John C. Seher
Managers

Sierra Environmental Monitoring, Inc.

Laboratory Analysis Report

City of Fallon
55 West Williams Ave
Fallon, NV 89406
Attn: Paul Strasdin

Date: 7/28/00
Client: FAL-017
Taken by: T.Runnells-Shep
Report: 35182
PO #: 35250

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1303	CW-04-01-000526 : #1,2,3,4,7,8,9	5/26/00	8:45 AM	5/26/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Alkalinity, Total	EPA 310.1	217	mg/L CaCO3		Tretten	5/30/00
Alkalinity/Bicarbonate	EPA 310.1	169	mg/L CaCO3		Tretten	5/30/00
Alkalinity/Carbonate	EPA 310.1	48	mg/L CaCO3		Tretten	5/30/00
Alkalinity/Hydroxide	EPA 310.1	<1	mg/L CaCO3		Tretten	5/30/00
pH	EPA 150.1	9.31	pH Units	6.5 to 8.5	Tretten	5/30/00
Turbidity	EPA 180.1	< 0.1	NTU		Kobza	5/26/00
C[illegible] Apparent	EPA 110.2	< 5	Color Units	15	Kobza	5/26/00
Total Dissolved Solids	EPA 160.1	532	mg/L	500/1000 mg/L	Rivera	6/7/00
Suspended Solids	EPA 160.2	<1	mg/L		Rivera	6/1/00
Nitrate-N - Ion Chromatography	EPA 300.0	<0.3N	mg/L	10 mg/L as N	Lowe	5/26/00
Nitrite-N - Ion Chromatography	EPA 300.0	<0.5N	mg/L	1 mg/L as N	Lowe	5/26/00
Phosphorus - Total	EPA 365.3	0.2	mg/L		Kleinworth	6/30/00
NO3 + NO2	EPA 300.0	<0.8N	mg/L		Lowe	5/26/00
Calcium - ICP-OES	EPA 200.7	1.3	mg/L		Jones	6/1/00
Magnesium - ICP-OES	EPA 200.7	0.46	mg/L	125 mg/L	Jones	6/1/00
Potassium - ICP-OES	EPA 200.7	6.7	mg/L		Jones	6/1/00
Sodium - ICP-OES	EPA 200.7	190	mg/L		Jones	6/1/00
Chloride - Ion Chromatography	EPA 300.0	97	mg/L	250 mg/L	Lowe	5/26/00
Fluoride - Ion Chromatography	EPA 300.0	<1	mg/L	2.0/4.0 mg/L	Lowe	5/26/00
Silica	EPA 370.1	26	mg/L		Tretten	5/31/00
Sulfate - Ion Chromatography	EPA 300.0	90	mg/L	500 mg/L	Lowe	5/26/00
Antimony - ICP-MS	EPA 200.8	< 0.002	mg/L	0.006 mg/L	Lambert	6/9/00
Aluminum - ICP-OES	EPA 200.7	<0.05	mg/L	0.05 to 0.2 mg/L	Faulstich	6/1/00
Arsenic - ICP-MS	EPA 200.8	0.1	mg/L	0.05 mg/L	Lambert	6/5/00
Barium - ICP-MS	EPA 200.8	< 0.002	mg/L	2.0 mg/L	Lambert	6/9/00
Beryllium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.004 mg/L	Lambert	6/9/00
Cadmium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.005 mg/L	Lambert	6/9/00
Chromium - ICP-MS	EPA 200.8	0.006	mg/L	0.1 mg/L	Lambert	6/9/00
Silver - ICP-MS	EPA 200.8	< 0.002	mg/L	0.1 mg/L	Lambert	6/9/00
Copper - ICP-MS	EPA 200.8	< 0.002	mg/L	1.0 mg/L	Lambert	6/9/00
Iron - ICP-OES	EPA 200.7	<0.05	mg/L	0.3 mg/L	Faulstich	6/1/00
L[illegible] ICP-MS	EPA 200.8	< 0.002	mg/L	0.015 mg/L	Lambert	6/9/00

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Managers

Sierra Environmental Monitoring, Inc.

Laboratory Analysis Report

City of Fallon
55 West Williams Ave
Fallon, NV 89406
Attn: Paul Strasdin

Date: 7/28/00
Client: FAL-017
Taken by: T.Runnells-Shep
Report: 35182
PO #: 35250

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1303	CW-04-01-000526 - #1,2,3,4,7,8,9	5/26/00	8:45 AM	5/26/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Manganese - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	6/9/00
Mercury - AA Cold Vapor	EPA 245.1	< 0.0005	mg/L	0.002 mg/L	Kobza	6/7/00
Nickel - ICP-MS	EPA 200.8	< 0.002	mg/L	0.1 mg/L	Lambert	6/9/00
Selenium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	6/9/00
Thallium - ICP-MS	EPA 200.8	< 0.001	mg/L	0.002 mg/L	Lambert	6/9/00
Zir ICP-MS	EPA 200.8	< 0.02	mg/L	5 mg/L	Lambert	6/9/00
Gr lpha and Beta Radiologic	Subcontract	See Report				6/21/00
Radium 226 - Radiological	Subcontract	See Report				7/28/00

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1304	CW-04-01-000526 - #12	5/26/00	8:45 AM	5/26/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.11	mg/L	0.05 mg/L	Lambert	6/5/00

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1305	CW-04-01-000526 - #5	5/26/00	8:45 AM	5/26/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.1	mg/L	0.05 mg/L	Lambert	6/5/00
Chromium - ICP-MS	EPA 200.8	0.01	mg/L	0.1 mg/L	Lambert	6/9/00

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1306	CW-04-01-000526 - #11	5/26/00	8:45 AM	5/26/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.095	mg/L	0.05 mg/L	Lambert	6/5/00

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Laboratory Analysis Report

City of Fallon
55 West Williams Ave
Fallon, NV 89406
Attn: Paul Strasdin

Date: 7/28/00
Client: FAL-017
Taken by: T.Runnells-Shep
Report: 35182
PO #: 35250

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1307	CW-04-01-000526 - #10	5/26/00	8:45 AM	5/26/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.002	mg/L	0.05 mg/L	Lambert	6/5/00

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1308	CW-04-01-000526 - #6	5/26/00	8:45 AM	5/26/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic Trivalent - ICP-MS	EPA 200.8	< 0.002	mg/L		Lambert	6/8/00
Arsenic Pentivalent - ICP-MS	EPA 200.8	0.12	mg/L		Lambert	6/8/00
Arsenic - ICP-MS	EPA 200.8	0.094	mg/L	0.05 mg/L	Lambert	6/5/00
Arsenic Speciation	Ficklin 1983	Completed			Tretten	5/30/00

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Laboratory Analysis Report

City of Fallon
55 West Williams Ave
Fallon, NV 89406
Attn: Paul Strasdin

Date: 7/28/00
Client: FAL-017
Taken by: T.Runnells-Shep
Report: 35182
PO #: 35250

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1309	CW-04-03-000526 - #1,2,3,4,7,8,9	5/26/00	10:30 AM	5/26/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Alkalinity, Total	EPA 310.1	2	mg/L CaCO3		Tretten	5/30/00
Alkalinity/Bicarbonate	EPA 310.1	2	mg/L CaCO3		Tretten	5/30/00
Alkalinity/Carbonate	EPA 310.1	<1	mg/L CaCO3		Tretten	5/30/00
Alkalinity/Hydroxide	EPA 310.1	<1	mg/L CaCO3		Tretten	5/30/00
pH	EPA 150.1	5.58	pH Units	6.5 to 8.5	Tretten	5/30/00
Turbidity	EPA 180.1	< 0.1	NTU		Kobza	5/26/00
Color, Apparent	EPA 110.2	< 5	Color Units	15	Kobza	5/26/00
Total Dissolved Solids	EPA 160.1	<7	mg/L	500/1000 mg/L	Rivera	6/7/00
Suspended Solids	EPA 160.2	<1	mg/L		Rivera	6/1/00
Nitrate-N - Ion Chromatography	EPA 300.0	<0.1N	mg/L	10 mg/L as N	Lowe	5/26/00
Nitrite-N - Ion Chromatography	EPA 300.0	<0.1N	mg/L	1 mg/L as N	Lowe	5/26/00
Phosphorus - Total	EPA 365.3	<0.02	mg/L		Kleinworth	6/30/00
NO3 + NO2	EPA 300.0	<0.2N	mg/L		Lowe	5/26/00
Calcium - ICP-OES	EPA 200.7	<0.1	mg/L		Jones	6/1/00
Magnesium - ICP-OES	EPA 200.7	<0.1	mg/L	125 mg/L	Jones	6/1/00
Potassium - ICP-OES	EPA 200.7	<0.5	mg/L		Jones	6/1/00
Sodium - ICP-OES	EPA 200.7	2.7	mg/L		Jones	6/1/00
Chloride - Ion Chromatography	EPA 300.0	<0.1	mg/L	250 mg/L	Lowe	5/26/00
Fluoride - Ion Chromatography	EPA 300.0	<0.1	mg/L	2.0/4.0 mg/L	Lowe	5/26/00
Silica	EPA 370.1	<1	mg/L		Tretten	5/31/00
Sulfate - Ion Chromatography	EPA 300.0	<0.1	mg/L	500 mg/L	Lowe	5/26/00
Antimony - ICP-MS	EPA 200.8	< 0.002	mg/L	0.006 mg/L	Lambert	6/9/00
Aluminum - ICP-OES	EPA 200.7	<0.05	mg/L	0.05 to 0.2 mg/L	Faulstich	6/1/00
Arsenic - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	6/5/00
Barium - ICP-MS	EPA 200.8	< 0.002	mg/L	2.0 mg/L	Lambert	6/9/00
Beryllium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.004 mg/L	Lambert	6/9/00
Cadmium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.005 mg/L	Lambert	6/9/00
Chromium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.1 mg/L	Lambert	6/9/00
Silver - ICP-MS	EPA 200.8	< 0.002	mg/L	0.1 mg/L	Lambert	6/9/00
Copper - ICP-MS	EPA 200.8	< 0.002	mg/L	1.0 mg/L	Lambert	6/9/00
Iron - ICP-OES	EPA 200.7	<0.05	mg/L	0.3 mg/L	Faulstich	6/1/00
Lead - ICP-MS	EPA 200.8	< 0.002	mg/L	0.015 mg/L	Lambert	6/9/00

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John C. Seher
Managers

Sierra Environmental Monitoring, Inc.

Laboratory Analysis Report

City of Fallon
55 West Williams Ave
Fallon, NV 89406
Attn: Paul Strasdin

Date: 7/28/00
Client: FAL-017
Taken by: T.Runnells-Shep
Report: 35182
PO #: 35250

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1309	CW-04-03-000526 - #1,2,3,4,7,8,9	5/26/00	10:30 AM	5/26/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Manganese - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	6/9/00
Mercury - AA Cold Vapor	EPA 245.1	< 0.0005	mg/L	0.002 mg/L	Kobza	6/7/00
Nickel - ICP-MS	EPA 200.8	< 0.002	mg/L	0.1 mg/L	Lambert	6/9/00
Selenium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	6/9/00
Thallium - ICP-MS	EPA 200.8	< 0.001	mg/L	0.002 mg/L	Lambert	6/9/00
Zinc - ICP-MS	EPA 200.8	< 0.02	mg/L	5 mg/L	Lambert	6/9/00
Gr lpha and Beta Radiologic	Subcontract	See Report				6/21/00

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1310	CW-04-03-000526 - #12	5/26/00	10:30 AM	5/26/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	6/5/00

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1311	CW-04-03-000526 - #5	5/26/00	10:30 AM	5/26/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	6/5/00
Chromium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.1 mg/L	Lambert	6/9/00

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1312	CW-04-03-000526 - #11	5/26/00	10:30 AM	5/26/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	6/5/00

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Laboratory Analysis Report

City of Fallon
55 West Williams Ave
Fallon, NV 89406
Attn: Paul Strasdin

Date: 7/28/00
Client: FAL-017
Taken by: T.Runnells-Shep
Report: 35182
PO #: 35250

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1313	CW-04-03-000526 - #10	5/26/00	10:30 AM	5/26/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.003	mg/L	0.05 mg/L	Lambert	6/5/00

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1314	CW-04-03-000526 - #6	5/26/00	10:30 AM	5/26/00

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic Trivalent - ICP-MS	EPA 200.8	< 0.002	mg/L		Lambert	6/8/00
Arsenic Pentivalent - ICP-MS	EPA 200.8	< 0.002	mg/L		Lambert	6/8/00
Arsenic - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	6/5/00
Arsenic Speciation	Ficklin 1983	Completed			Tretten	5/30/00

SAMPLE WATER AS TESTED ____ DID ____ DID NOT MEET DRINKING WATER STANDARDS.

Approved By: _____ Date: 7-28-00
Sierra Environmental Monitoring, Inc

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Laboratory Analysis Report

Sierra Environmental Monitoring, Inc.

City of Fallon
55 West Williams Ave
Fallon, NV 89406
Attn: Paul Strasdin

Date: 06/26/2000
Client: FAL-017
Taken by: T.Runnells-Shep
Report: 35147
PO #: 35250

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1156	NW-01-01-000524 - #1,2,3,4,7,8,9,13	05/24/2000		05/24/2000

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Alkalinity, Total	EPA 310.1	226	mg/L CaCO3		Tretten	06/01/2000
Alkalinity/Bicarbonate	EPA 310.1	182	mg/L CaCO3		Tretten	06/01/2000
Alkalinity/Carbonate	EPA 310.1	44	mg/L CaCO3		Tretten	06/01/2000
Alkalinity/Hydroxide	EPA 310.1	<1	mg/L CaCO3		Tretten	06/01/2000
pH	EPA 150.1	9.35	pH Units	6.5 to 8.5	Tretten	05/25/2000
Turbidity	EPA 180.1	<0.1	NTU		Kobza	05/25/2000
Co[illegible] Apparent	EPA 110.2	<5	Color Units	15	Kobza	05/25/2000
To[illegible] ssolved Solids	EPA 160.1	578	mg/L	500/1000 mg/L	Rivera	05/24/2000
Suspended Solids	EPA 160.2	1	mg/L		Rivera	05/24/2000
Nitrate-N - Ion Chromatography	EPA 300.0	<0.3N	mg/L	10 mg/L as N	Tretten	05/25/2000
Nitrite-N - Ion Chromatography	EPA 300.0	<0.5N	mg/L	1 mg/L as N	Tretten	05/25/2000
NO3 + NO2	EPA 300.0	<0.8N	mg/L		Tretten	05/25/2000
Calcium - ICP-OES	EPA 200.7	1.1	mg/L		Jones	06/01/2000
Magnesium - ICP-OES	EPA 200.7	0.44	mg/L	125 mg/L	Jones	06/01/2000
Potassium - ICP-OES	EPA 200.7	7.4	mg/L		Jones	06/01/2000
Sodium - ICP-OES	EPA 200.7	220	mg/L		Jones	06/01/2000
Chloride - Ion Chromatography	EPA 300.0	110	mg/L	250 mg/L	Tretten	05/25/2000
Fluoride - Ion Chromatography	EPA 300.0	<1	mg/L	2.0/4.0 mg/L	Tretten	05/25/2000
Silica	EPA 370.1	24	mg/L		Tretten	05/31/2000
Sulfate - Ion Chromatography	EPA 300.0	94	mg/L	500 mg/L	Tretten	05/25/2000
Antimony - ICP-MS	EPA 200.8	< 0.002	mg/L	0.006 mg/L	Lambert	06/02/2000
Aluminum - ICP-OES	EPA 200.7	<0.05	mg/L	0.05 to 0.2 mg/L	Faulstich	06/01/2000
Arsenic - ICP-MS	EPA 200.8	0.12	mg/L	0.05 mg/L	Lambert	06/02/2000
Barium - ICP-MS	EPA 200.8	< 0.002	mg/L	2.0 mg/L	Lambert	06/02/2000
Beryllium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.004 mg/L	Lambert	06/02/2000
Cadmium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.005 mg/L	Lambert	06/02/2000
Chromium - ICP-MS	EPA 200.8	0.009	mg/L	0.1 mg/L	Lambert	06/02/2000
Silver - ICP-MS	EPA 200.8	< 0.002	mg/L	0.1 mg/L	Lambert	06/02/2000
Copper - ICP-MS	EPA 200.8	< 0.002	mg/L	1.0 mg/L	Lambert	06/02/2000
Iron - ICP-OES	EPA 200.7	<0.05	mg/L	0.3 mg/L	Faulstich	06/01/2000
Lead - ICP-MS	EPA 200.8	< 0.002	mg/L	0.015 mg/L	Lambert	06/02/2000
Manganese - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	06/02/2000

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Laboratory Analysis Report

Sierra Environmental Monitoring, Inc.

City of Fallon
55 West Williams Ave
Fallon, NV 89406
Attn: Paul Strasdin

Date: 06/26/2000
Client: FAL-017
Taken by: T.Runnells-Shep
Report: 35147
PO #: 35250

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1156	NW-01-01-000524 - #1,2,3,4,7,8,9,13	05/24/2000		05/24/2000

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Mercury - AA Cold Vapor	EPA 245.1	<0.0005	mg/L	0.002 mg/L	Rivera	06/02/2000
Nickel - ICP-MS	EPA 200.8	< 0.002	mg/L	0.1 mg/L	Lambert	06/02/2000
Selenium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	06/02/2000
Thallium - ICP-MS	EPA 200.8	< 0.001	mg/L	0.002 mg/L	Lambert	06/02/2000
Zinc - ICP-MS	EPA 200.8	< 0.02	mg/L	5 mg/L	Lambert	06/02/2000
Radon	Subcontract	See Report				06/26/2000
G Alpha and Beta Radiologic	Subcontract	See Report				06/21/2000

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1157	NW-01-01-000524 - #12	05/24/2000		05/24/2000

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.12	mg/L	0.05 mg/L	Lambert	06/05/2000

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1158	NW-01-01-000524 - #5	05/24/2000		05/24/2000

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.11	mg/L	0.05 mg/L	Lambert	06/05/2000
Chromium - ICP-MS	EPA 200.8	0.008	mg/L	0.1 mg/L	Lambert	06/09/2000

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1159	NW-01-01-000524 - #11	05/24/2000		05/24/2000

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.099	mg/L	0.05 mg/L	Lambert	06/05/2000

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sem@powernet.net

William F. Pillsbury
President

John Kobza, Ph.D.
John C. Seher
Managers

Laboratory Analysis Report

Sierra Environmental Monitoring, Inc.

City of Fallon
55 West Williams Ave
Fallon, NV 89406
Attn: Paul Strasdin

Date: 06/26/2000
Client: FAL-017
Taken by: T.Runnells-Shep
Report: 35147
PO #: 35250

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1160	NW-01-01-000524 - #10	05/24/2000		05/24/2000

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	06/05/2000

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1161	NW-01-01-000524 - #6	05/24/2000		05/24/2000

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic Trivalent - ICP-MS	EPA 200.8	< 0.002	mg/L		Lambert	06/08/2000
Arsenic Pentivalent - ICP-MS	EPA 200.8	0.13	mg/L		Lambert	06/08/2000
Arsenic - ICP-MS	EPA 200.8	0.1	mg/L	0.05 mg/L	Lambert	06/05/2000
Arsenic Speciation	Ficklin 1983	Completed			Tretten	05/26/2000

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Laboratory Analysis Report

Sierra Environmental Monitoring, Inc.

City of Fallon
55 West Williams Ave
Fallon, NV 89406
Attn: Paul Strasdin

Date: 06/26/2000
Client: FAL-017
Taken by: T.Runnells-Shep
Report: 35147
PO #: 35250

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1162	NW-03-01-000524 - #1,2,3,4,7,8,9,13	05/24/2000		05/24/2000

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Alkalinity, Total	EPA 310.1	230	mg/L CaCO3		Tretten	06/01/2000
Alkalinity/Bicarbonate	EPA 310.1	182	mg/L CaCO3		Tretten	06/01/2000
Alkalinity/Carbonate	EPA 310.1	48	mg/L CaCO3		Tretten	06/01/2000
Alkalinity/Hydroxide	EPA 310.1	<1	mg/L CaCO3		Tretten	06/01/2000
pH	EPA 150.1	9.34	pH Units	6.5 to 8.5	Tretten	05/25/2000
Turbidity	EPA 180.1	<0.1	NTU		Kobza	05/25/2000
Col[illegible]parent	EPA 110.2	<5	Color Units	15	Kobza	05/25/2000
Tota[illegible]solved Solids	EPA 160.1	615	mg/L	500/1000 mg/L	Rivera	05/26/2000
Suspended Solids	EPA 160.2	1	mg/L		Rivera	05/26/2000
Nitrate-N - Ion Chromatography	EPA 300.0	<0.3N	mg/L	10 mg/L as N	Tretten	05/25/2000
Nitrite-N - Ion Chromatography	EPA 300.0	<0.5N	mg/L	1 mg/L as N	Tretten	05/25/2000
NO3 + NO2	EPA 300.0	<0.8N	mg/L		Tretten	05/25/2000
Calcium - ICP-OES	EPA 200.7	1.1	mg/L		Jones	06/01/2000
Magnesium - ICP-OES	EPA 200.7	0.44	mg/L	125 mg/L	Jones	06/01/2000
Potassium - ICP-OES	EPA 200.7	6.9	mg/L		Jones	06/01/2000
Sodium - ICP-OES	EPA 200.7	210	mg/L		Jones	06/01/2000
Chloride - Ion Chromatography	EPA 300.0	110	mg/L	250 mg/L	Tretten	05/25/2000
Fluoride - Ion Chromatography	EPA 300.0	<1	mg/L	2.0/4.0 mg/L	Tretten	05/25/2000
Silica	EPA 370.1	24	mg/L		Tretten	05/31/2000
Sulfate - Ion Chromatography	EPA 300.0	95	mg/L	500 mg/L	Tretten	05/25/2000
Antimony - ICP-MS	EPA 200.8	< 0.002	mg/L	0.006 mg/L	Lambert	06/02/2000
Aluminum - ICP-OES	EPA 200.7	<0.05	mg/L	0.05 to 0.2 mg/L	Faulstich	06/01/2000
Arsenic - ICP-MS	EPA 200.8	0.12	mg/L	0.05 mg/L	Lambert	06/02/2000
Barium - ICP-MS	EPA 200.8	< 0.002	mg/L	2.0 mg/L	Lambert	06/02/2000
Beryllium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.004 mg/L	Lambert	06/02/2000
Cadmium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.005 mg/L	Lambert	06/02/2000
Chromium - ICP-MS	EPA 200.8	0.007	mg/L	0.1 mg/L	Lambert	06/02/2000
Silver - ICP-MS	EPA 200.8	< 0.002	mg/L	0.1 mg/L	Lambert	06/02/2000
Copper - ICP-MS	EPA 200.8	0.006	mg/L	1.0 mg/L	Lambert	06/02/2000
Iron - ICP-OES	EPA 200.7	<0.05	mg/L	0.3 mg/L	Faulstich	06/01/2000
Lead - ICP-MS	EPA 200.8	< 0.002	mg/L	0.015 mg/L	Lambert	06/02/2000
Mang[illegible]ese - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	06/02/2000

William F. Pillsbury
President

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John Kobza, Ph.D.
John C. Seher
Managers

Laboratory Analysis Report

Sierra Environmental Monitoring, Inc.

City of Fallon
55 West Williams Ave
Fallon, NV 89406
Attn: Paul Strasdin

Date: 06/26/2000
Client: FAL-017
Taken by: T.Runnells-Shep
Report: 35147
PO #: 35250

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1162	NW-03-01-000524 - #1,2,3,4,7,8,9,13	05/24/2000		05/24/2000

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Mercury - AA Cold Vapor	EPA 245.1	<0.0005	mg/L	0.002 mg/L	Rivera	06/02/2000
Nickel - ICP-MS	EPA 200.8	< 0.002	mg/L	0.1 mg/L	Lambert	06/02/2000
Selenium - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	06/02/2000
Thallium - ICP-MS	EPA 200.8	< 0.001	mg/L	0.002 mg/L	Lambert	06/02/2000
Zinc - ICP-MS	EPA 200.8	< 0.02	mg/L	5 mg/L	Lambert	06/02/2000
Radon	Subcontract	See Report				06/26/2000
G Alpha and Beta Radiologic	Subcontract	See Report				06/21/2000

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1163	NW-03-01-000524 - #12	05/24/2000		05/24/2000

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.12	mg/L	0.05 mg/L	Lambert	06/05/2000

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1164	NW-03-01-000524 - #5	05/24/2000		05/24/2000

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.11	mg/L	0.05 mg/L	Lambert	06/05/2000
Chromium - ICP-MS	EPA 200.8	0.011	mg/L	0.1 mg/L	Lambert	06/09/2000

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1165	NW-03-01-000524 - #11	05/24/2000		05/24/2000

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	0.099	mg/L	0.05 mg/L	Lambert	06/05/2000

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John C. Seher
Managers

Laboratory Analysis Report

Sierra Environmental Monitoring, Inc.

City of Fallon
55 West Williams Ave
Fallon, NV 89406
Attn: Paul Strasdin

Date: 06/26/2000
Client: FAL-017
Taken by: T.Runnells-Shep
Report: 35147
PO #: 35250

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1166	NW-03-01-000524 - #10	05/24/2000		05/24/2000

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
Arsenic - ICP-MS	EPA 200.8	< 0.002	mg/L	0.05 mg/L	Lambert	06/05/2000

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1167	NW-03-01-000524 - #6	05/24/2000		05/24/2000

Parameter	Method	Result	Units Of Measure	MCL	Analyst	Date Analyzed
A[illegible]c Trivalent - ICP-MS	EPA 200.8	< 0.002	mg/L		Lambert	06/08/2000
Arsenic Pentivalent - ICP-MS	EPA 200.8	0.13	mg/L		Lambert	06/08/2000
Arsenic - ICP-MS	EPA 200.8	0.1	mg/L	0.05 mg/L	Lambert	06/05/2000
Arsenic Speciation	Ficklin 1983	Completed			Tretten	05/26/2000

SAMPLE WATER AS TESTED ____ DID ____ DID NOT MEET DRINKING WATER STANDARDS.

Approved By: [illegible] **Date:** 6/26/00
Sierra Environmental Monitoring, Inc

This report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report is for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

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powernet.net

William F. Pillsbury
President

John Kobza, Ph.D.
John C. Seher
Managers

2000
TIME OFF SUMMARY
April 1 - June 30, 2000

Employee: Runnells, Tim
Hire Date: 06/29/1992
Status: Full-time

	VACATION TIME 30 hrs per Q	SICK LEAVE 10 hrs per Q	PERSONAL TIME 16 hrs per yr
FIRST QUARTER			
CARRY OVER	129.50	26.50	16.00
EARNED	20.00	10.00	N/A
EXPENDED	8.00	10.00	0.00
BALANCE Q1	141.50	26.50	16.00
SECOND QUARTER			
CARRY OVER	141.50	26.50	16.00
EARNED	34.25	10.00	N/A
EXPENDED	80.00	13.00	0.00
BALANCE Q2	95.75	23.50	16.00
THIRD QUARTER			
CARRY OVER	95.75	23.50	16.00
EARNED	30.00	10.00	N/A
EXPENDED	0.00	0.00	0.00
BALANCE Q3	125.75	33.50	16.00
FOURTH QUARTER			
CARRY OVER	125.75	33.50	16.00
EARNED	30.00	10.00	N/A
EXPENDED	0.00	0.00	0.00
BALANCE Q4	155.75	40.00	16.00

NOTES:
04/21/2000 Worked 4.25 hours on a holiday. Hours added to vacation time.

Sierra Environmental Monitoring, Inc.

Laboratory Analysis Report

City of Fallon
Attn: Paul Strasdin
55 West Williams Ave
Fallon, NV 89406

Date: 7/31/00
Client: FAL-017
Taken by: T.Runnells-Shep
Report: 35162
PO #: 35250

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1209	CW-01-01-000525 - #1,2,3,4,7,8,9,13	5/25/00		5/25/00

Parameter	Method	Result	Units Of Measure	Detection Limit	Analyst	Date Analyzed
Radium 226 - Radiological	Subcontract	See Report		0		7/28/00

Approved By: _____ **Date:** _____
Sierra Environmental Monitoring, Inc

This report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report is for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

Feral Report

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William F. Pillsbury
President

John Kobza, Ph.D.
John C. Seher
Managers

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

for

Sierra Environmental Monitoring,
Inc.
1135 Financial Blvb.

Reno , NV 89502

Attention: Mike Brisbin
Fax: (775) 857-2404

DATE OF ISSUE
JUL 26 2000
MONTGOMERY WATSON LABS

HDS Hillary Strayer
Project Manager

Report#: 67404
DRINKING

Laboratory certifies that the test results meet all **QA/QC** requirements unless noted in the Comments section or the Case Narrative. Following the cover page are Comments,QC Summary,Data Report, totaling 3 page[s].

Montgomery Watson Laboratories
555 E. Walnut St., Pasadena, CA 91101
PHONE: 626-568-6400/FAX: 626-568-6324

ACKNOWLEDGMENT OF SAMPLES RECEIVED

Sierra Environmental Monitoring, Inc.
1135 Financial Blvb.
Reno, NV 89502
Attn: Mike Brisbin
Phone: (775) 857-2400

Customer Code: SIERRAENV
Group#: 67404
Project#: DRINKING
Proj Mgr: Hillary Strayer
Phone: (626) 568-6412

The following samples were received from you on **06/27/00**. They have been scheduled for the tests listed beside each sample. If this information is incorrect, please contact your service representative. Thank you for using Montgomery Watson Laboratories.

Sample#	Sample Id	Tests Scheduled	Matrix	Sample Date
2006270011	(200005-1209)	CW-01-01-000525 @RA226	Water	25-may-2000

Test Acronym Description

Test Acronym	Description
@RA226	Radium 226 (Sub)

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Report
Comments
#67404

(Sample#: 2006270011)
Test: Radium 226 (Sub)
RESULT IS SUBMITTED BY GEL.

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory
Data Report
#67404

Sierra Environmental Monitoring,
Inc.
Mike Brisbin
1135 Financial Blvd.
Reno , NV 89502

Samples Received

06/27/00

Prepared	Analyzed	QC Batch#	Method	Analyte	Result	Units	MRL	Dilution
(200005-1209) CW-01-01-000525 (2006270011) Sampled on 05/25/00 12:00								
				Radium 226 (Sub) ,				
	07/05/00 04:38	120260	(ML/EPA 903.1)	Radium 226	<0.471	pCi/l	0.47	1
	07/05/00 04:38	120260	(EPA 903.1)	Radium 226, Two Sigma Error	NA	pCi/l	0.0000	1
	07/05/00 04:38	120260	(EPA 903)	Radium 226, Minimal Detectable	0.471	pCi/l	0.0000	1

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory
QC Summary
#67404

Sierra Environmental Monitoring,
Inc.

QC Batch #120260 - Radium 226 (Sub) **Analysis Date: 07/05/2000**

2006270011 (200005-1209) CW-01-01-000525

Mon[illegible]nery Watson Laboratories
555 East Walnut Street
Pasadena, CA 91101
Ph (626) 568-6400 Fax (626) 568-6324

Ship To Lee Heath
General Engineering

2040 Savage Road
Charleston, SC 29414

(843) 556-8171 X4433 Fax (843) 766-1178

MWL Project # 67404
Report Due: 07/22/00

Date 06/27/00 **Submittal Form** HDS .04

Reporting: **One report for this MWL Project Number:** 67404
Do Not Combine Report with any other samples submitted under different MWL project numbers!
Report & Invoice must have the MWL Project Number and Sub PO#: 99-2643
Report all quality control data according to Method. Include dates analyzed, date extracted (if extracted) and Method reference on the report. Fax results to 626-568-6324
Faxed results must have complete data &QC. Hardcopy report is due in hand on due date.
Please advise us immediately if Due Date will be missed.

SIERRAENV

HARDCOPY REPORT, FORMS, & INVOICE MUST BE SENT TO ATTENTION
Martha Frost, Sub-contracting Administrator
Montgomery Watson Laboratories 555 East Walnut Street Pasadena, CA 91101
Phone (626) 568-6437 Fax (626) 568-6324

For Specific Questions about samples Hillary Strayer (626) 568-6412

Please provide radiological results for all tests in decimal format with **three decimal places** (not scientific notation) **in Pico Curies per Liter with 2-Sigma Counting Error.**

*****The DRL as defined by the State of California must be reported on the report for all radiological testing. Still need even though samples are for drinking water compliance in the State of Nevada-certification still in effect per Julie Strock/GEL**

Qty	Test Code	Use MWL Lab # for ID	Client Sample ID for reference only	Analysis Requested	Sample Date & Time	Matrix	Container
1	@RA226	2006270011	(200005-1209) CW-01-01-000525	Radioactivity, Radium 226	05/25/00 -	dw	1 1L poly + 4ml HNO3 (18%)

Relinquished by: [signature] Sample Control Date 06/27/00 Time 15:00
Received by: Patricia Downs Date 6/28/00 Time 09:30 An Acknowledgement of Receipt is requested to attn: Martha Frost

7/21 SIERRAENU 67404

GENERAL ENGINEERING LABORATORIES

Meeting today's needs with a vision for tomorrow.

Certificate of Analysis

Company : Montgomery Laboratories
Address : 555 East Walnut Street
Pasadena, CA 91101

Report Date: July 20, 2000

Contact: Ms. Martha Frost
Project: Routine Analytical

Client Sample ID:	2006270011	Project:	MLAB00195
Sample,ID:	27617001	Client ID:	MLAB001
Matrix:	Drinking Water (Potable)		
Collect Date:	25-MAY-00		
Receive Date:	28-JUN-00		
Collector:	Client		

Parameter	Qualifier	Result		DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Radium-226											
Lucas Cell. Ra226, liquid											
Radium-226	U	0.400	+/-0.358	0.471	0.500	pCi/L	1	RDD 07/05/00	1040	32252	1

The following Analytical Methods were performed

Method	Description
1	EPA 903.1

s:
The Qualifiers in this report are defined as follows :

* Indicates that a quality control analyte recovery is outside of specified acceptance criteria.
** Indicates the analyte is a surrogate compound.
< Actual result is less than amount reported
> Actual result is greater than amount reported
J Indicates an estimated value. The result was greater than the detection limit, but less than the reporting limit.
U Indicates the compound was analyzed for but not detected above the detection limit

The above sample is reported on an "as received" basis.

This data report has been prepared and reviewed in accordance with General Engineering Laboratories, Inc. standard operating procedures. Please direct any questions to your Project Manager, Julia Strock at 843-556-8171 Ext. 4247.

Julia Strock
Reviewed by

P O Box 30712 • Charleston, SC 29417 • 2040 Savage Road • 29407
(843) 556-8171 • Fax (843) 766-1178

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GENERAL ENGINEERING LABORATORIES

Meeting today's needs with a vision for tomorrow.

QC Summary

Report Date: July 20, 2000
Page 1 of 1

Client : Montgomery Laboratories
555 East Walnut Street
Pasadena, CA 91101

Contact: Ms. Martha Frost

Workorder: 27617

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date Time
Rad Radium-226										
Batch 32252										
QC1000072024 27621004 DUP										
Radium-226	U	0.0619 +/-0.272	U	0.463 +/-0.468	pCi/L	153*		(0%-20%)	RDD	07/05/00 12:45
QC1000072025 27583001 DUP										
Radium-226		0.947 +/-0.593		0.883 +/-0.549	pCi/L	7		(0%-20%)		
QC1000072027 LCS										
Radium-226	20.3			17.8 +/-2.18	pCi/L		88	(75%-125%)		
QC1000072023 MB										
Radium-226			U	0.260 +/-0.313	pCi/L					07/05/00 11:40
QC1000072026 27583001 MS										
Radium-226	20.3	0.947 +/-0.593		17.5 +/-2.18	pCi/L		81	(75%-125%)		07/05/00 12:45

Qualifiers in this report are defined as follows:

- Indicates that a quality control analyte recovery is outside of specified acceptance criteria.
- ** Indicates the analyte is a surrogate compound.
- < Actual result is less than amount reported
- > Actual result is greater than amount reported
- J Indicates an estimated value. The result was greater than the detection limit, but less than the reporting limit.
- U Indicates the compound was analyzed for but not detected above the detection limit

N/A indicates that spike recovery limits do not apply when sample concentration exceeds spike conc. by a factor of 4 or more.
For PS, PSD, and SDILT results, the values listed are the measured amounts, not final concentrations.

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MONTGOMERY WATSON LABORATORIES
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555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6480 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

for

Sierra Environmental Monitoring,
Inc.
1135 Financial Blvb.

Reno , NV 89502

Attention: Mike Brisbin
Fax: (775) 857-2404

DATE OF ISSUE
JUN 1 6 2000
MONTGOMERY WATSON LABS

HDS Hillary Strayer
Project Manager

Report#: 66592
DRINKING

Laboratory certifies that the test results meet all QA/QC requirements unless noted in the Comments section or the Case Narrative. Following the cover page are QC Report,QC Summary,Data Report, totaling 3 page[s].

Montgomery Watson Laboratories
555 E. Walnut St., Pasadena, CA 91101
PHONE: 626-568-6400/FAX: 626-568-6324

ACKNOWLEDGMENT OF SAMPLES RECEIVED

Sierra Environmental Monitoring, Inc.
1135 Financial Blvb.
Reno, NV 89502
Attn: Mike Brisbin

Customer Code: SIERRAENV
PO#: 00-241
Group#: 66592
Project#: DRINKING
Proj Mgr: Hillary Strayer
Phone: (626) 568-6412

The following samples were received from you on 05/31/00. They have been scheduled for the tests listed beside each sample. If this information is incorrect, please contact your service representative. Thank you for using Montgomery Watson Laboratories.

Sample#	Sample Id	Tests Scheduled	Matrix	Sample Date
2006010267	(200005-1209)	CW-01-01-000525 @RAD	Water	05/25/00
2006010268	(200005-1215)	CW-01-02-000525 @RAD	Water	05/25/00
2006010269	(200005-1221)	CW-03-01-000525 @RAD	Water	05/25/00

Test Acronym Description

Test Acronym	Description
@RAD	Gross Alpha and Beta Radiation

MONTGOMERY WATSON LABORATORIES
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555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory
Data Report
#66592

Sierra Environmental Monitoring, Inc.
Mike Brisbin
1135 Financial Blvd.
Reno , NV 89502

Samples Received

05/31/00

Prepared	Analyzed	QC Batch#	Method	Analyte	Result	Units	MRL	Dilution
(200005-1209) CW-01-01-000525 (2006010267) Sampled on 05/25/00 12:00								
67404 for Radium 226								
				Gross Alpha and Beta Radiation				
06/13/00	08:14	117725	(ML/EPA 900.0)	Alpha, Gross	4.2	pCi/l	1.0	1
06/13/00	08:14	117725	(ML/EPA 900.0)	Alpha, Two Sigma Error	1.8	pCi/l	0.0000	1
06/13/00	08:14	117725	(ML/EPA 900.0)	Alpha, Min Detectable Activity	1.0	pCi/l	1.0	1
06/13/00	08:14	117725	(ML/EPA 900.0)	Beta, Gross	4.0	pCi/l	2.1	1
06/13/00	08:14	117725	(ML/EPA 900.0)	Beta, Two Sigma Error	3.4	pCi/l	0.0000	1
06/13/00	08:14	117725	(ML/EPA 900.0)	Beta, Min Detectable Activity	2.1	pCi/l	2.1	1
(200005-1215) CW-01-02-000525 (2006010268) Sampled on 05/25/00 12:00								
				Gross Alpha and Beta Radiation				
06/13/00	08:14	117725	(ML/EPA 900.0)	Alpha, Gross	2.8	pCi/l	1.0	1
06/13/00	08:14	117725	(ML/EPA 900.0)	Alpha, Two Sigma Error	1.9	pCi/l	0.0000	1
06/13/00	08:14	117725	(ML/EPA 900.0)	Alpha, Min Detectable Activity	1.0	pCi/l	1.0	1
06/13/00	08:14	117725	(ML/EPA 900.0)	Beta, Gross	6.9	pCi/l	1.2	1
06/13/00	08:14	117725	(ML/EPA 900.0)	Beta, Two Sigma Error	2.5	pCi/l	0.0000	1
06/13/00	08:14	117725	(ML/EPA 900.0)	Beta, Min Detectable Activity	1.2	pCi/l	1.2	1
(200005-1221) CW-03-01-000525 (2006010269) Sampled on 05/25/00 12:00								
				Gross Alpha and Beta Radiation				
06/13/00	08:15	117725	(ML/EPA 900.0)	Alpha, Gross	1.1	pCi/l	1.0	1
06/13/00	08:15	117725	(ML/EPA 900.0)	Alpha, Two Sigma Error	1.6	pCi/l	0.0000	1
06/13/00	08:15	117725	(ML/EPA 900.0)	Alpha, Min Detectable Activity	1.0	pCi/l	1.0	1
06/13/00	08:15	117725	(ML/EPA 900.0)	Beta, Gross	8.6	pCi/l	0.80	1
06/13/00	08:15	117725	(ML/EPA 900.0)	Beta, Two Sigma Error	1.7	pCi/l	0.0000	1
06/13/00	08:15	117725	(ML/EPA 900.0)	Beta, Min Detectable Activity	0.8	pCi/l	0.80	1

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Laboratory
QC Summary
#66592

Sierra Environmental Monitoring,
Inc.

QC Batch #117725 - Gross Alpha and Beta RadiationAnalysis Date: 06/13/2000

2006010267	(200005-1209)	CW-01-01-000525
2006010268	(200005-1215)	CW-01-02-000525
2006010269	(200005-1221)	CW-03-01-000525

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Laboratory
QC Report
#66592

Sierra Environmental Monitoring,
Inc.

QC Batch #117725 Gross Alpha and Beta Radiation

QC	Analyte	Spiked	Recovered	Yield (%)	Limits (%)	RPD (%)
LCS1	Alpha, Gross	38.9	42.3	108.7	(80.00 - 120.00)	
LCS2	Alpha, Gross	38.9	42.9	110.3	(80.00 - 120.00)	1.4
MS	Alpha, Gross	77.8	76.8	98.7	(80.00 - 120.00)	
LCS1	Beta, Gross	31.9	31.7	99.4	(80.00 - 120.00)	
LCS2	Beta, Gross	31.9	31.6	99.1	(80.00 - 120.00)	0.32
MS	Beta, Gross	63.8	57.7	90.4	(80.00 - 120.00)	

Spikes which exceed Limits and Method Blanks with positive results are highlighted by Underlining.
Criteria for MS and DUP are advisory only, batch control is based on LCS. Criteria for duplicates are advisory only, unless otherwise specified in the method.

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555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 5324
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Laboratory Report

for

Sierra Environmental Monitoring,
Inc.
1135 Financial Blvb.

Reno , NV 89502

Attention: Mike Brisbin
Fax: (775) 857-2404

DATE OF ISSUE
JUN 0 6 2000
MONTGOMERY WATSON LABS

HDS Hillary Strayer

Report#: 66399
DRINKING

Montgomery Watson Laboratories
555 E. Walnut St., Pasadena, CA 91101
PHONE: 626-568-6400/FAX: 626-568-6324

ACKNOWLEDGMENT OF SAMPLES RECEIVED

Sierra Environmental Monitoring, Inc.
1135 Financial Blvb.
Reno, NV 89502
Attn: Mike Brisbin
Phone: (775) 857-2400

Customer Code: SIERRAENV
Group#: 66399
Project#: DRINKING
Proj Mgr: Hillary Strayer
Phone: (626) 568-6412

The following samples were received from you on **05/26/00**. They have been scheduled for the tests listed beside each sample. If this information is incorrect, please contact your service representative. Thank you for using Montgomery Watson Laboratories.

Sample#	Sample Id	Matrix	Sample Date
	Tests Scheduled		
2005260051	(S200005-1209) CW-01-01-000525	Water	25-may-2000 08:15:00
	@RN		
2005260052	(S200005-1215) CW-01-02-000525	Water	25-may-2000 08:15:00
	@RN		
2005260053	(S200005-1221) CW-03-01-000525	Water	25-may-2000 13:30:00
	@RN		
2005260054	(S200005-1227) CW-04-01-000525	Water	25-may-2000 15:00:00
	@RN		

Test Acronym Description

Test Acronym	Description
@RN	Radon 222

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Pasadena, California 91101
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Laboratory
Report
#66399

Sierra Environmental Monitoring,
Inc.
Mike Brisbin
1135 Financial Blvd.
Reno , NV 89502

Samples Received

26-may-2000 09:30:00

Prepared	Analyzed	QC Batch#	Method	Analyte	Result	Units	MRL	Dilution
(S200005-1209) CW-01-01-000525 (2005260051) Sampled on 05/25/00								
			Radon 222					
	05/26/00	116939	(SM7500RN	) Radon 222	74	pCi/l	50	1
	05/26/00	116939	(SM7500RN	) Radon 222, Two Sigma Error	12	pCi/l	0.0000	1
(S200005-1215) CW-01-02-000525 (2005260052) Sampled on 05/25/00								
			Radon 222					
	05/26/00	116939	(SM7500RN	) Radon 222	90	pCi/l	50	1
	05/26/00	116939	(SM7500RN	) Radon 222, Two Sigma Error	13	pCi/l	0.0000	1
(S200005-1221) CW-03-01-000525 (2005260053) Sampled on 05/25/00								
			Radon 222					
	05/26/00	116939	(SM7500RN	) Radon 222	96	pCi/l	50	1
	05/26/00	116939	(SM7500RN	) Radon 222, Two Sigma Error	12	pCi/l	0.0000	1
(S200005-1227) CW-04-01-000525 (2005260054) Sampled on 05/25/00								
			Radon 222					
	05/26/00	116939	(SM7500RN	) Radon 222	88	pCi/l	50	1
	05/26/00	116939	(SM7500RN	) Radon 222, Two Sigma Error	12	pCi/l	0.0000	1

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Laboratory
QC Summary Report
#66399

Sierra Environmental Monitoring,
Inc.

QC Batch #116939 - Radon 222 Analysis Date: 05/26/2000

2005260051	(S200005-1209)	CW-01-01-000525
2005260052	(S200005-1215)	CW-01-02-000525
2005260053	(S200005-1221)	CW-03-01-000525
2005260054	(S200005-1227)	CW-04-01-000525

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Laboratory
QC Report
#66399

Sierra Environmental Monitoring,
Inc.

QC Batch #116939 Radon 222

QC	Analyte	Spiked	Recovered	Yield (%)	Limits (%)	RPD (%)
LCS1	Radon 222	1000	948	94.8	(80.00 - 120.00)	
LCS2	Radon 222	1000	908	90.8	(80.00 - 120.00)	4.3
MBLK	Radon 222	ND				

Spikes which exceed Limits and Method Blanks with positive results are highlighted by Underlining.
Criteria for MS and DUP are advisory only and not applicable for ICR monitoring.

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555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
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Laboratory Report

for

Sierra Environmental Monitoring,
Inc.
1135 Financial Blvb.

Reno , NV 89502

Attention: Mike Brisbin
Fax: (775) 857-2404

DATE OF ISSUE
JUN 1 6 2000
MONTGOMERY WATSON LABS

HDS Hillary Strayer
Project Manager

Report#: 66403
DRINKING

Laboratory certifies that the test results meet all **QA/QC** requirements unless noted in the Comments section or the Case Narrative. Following the cover page are QC Report,QC Summary,Data Report, totaling 3 page[s].

Montgomery Watson Laboratories
555 E. Walnut St., Pasadena, CA 91101
PHONE: 626-568-6400/FAX: 626-568-6324

ACKNOWLEDGMENT OF SAMPLES RECEIVED

Sierra Environmental Monitoring, Inc.
1135 Financial Blvb.
Reno, NV 89502
Attn: Mike Brisbin

Customer Code: SIERRAENV
PO#: 00-233
Group#: 66403
Project#: DRINKING
Proj Mgr: Hillary Strayer
Phone: (626) 568-6412

The following samples were received from you on 05/26/00. They have been scheduled for the tests listed beside each sample. If this information is incorrect, please contact your service representative. Thank you for using Montgomery Watson Laboratories.

Sample#	Sample Id	Tests Scheduled	Matrix	Sample Date
2005260058	(200005-1066) CW-02-01-000523	@RAD	Water	05/23/00

Test Acronym Description

Test Acronym	Description
@RAD	Gross Alpha and Beta Radiation

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Laboratory
Data Report
#66403

Sierra Environmental Monitoring, Inc.
Mike Brisbin
1135 Financial Blvb.
Reno , NV 89502

Samples Received

05/26/00

(200005-1066) CW-02-01-000523 (2005260058) Sampled on 05/23/00 12:00

Gross Alpha and Beta Radiation

Prepared	Analyzed	QC Batch#	Method	Analyte	Result	Units	MRL	Dilution
	06/07/00 03:52	117260	(ML/EPA 900.0)	Alpha, Gross	3.1	pCi/l	1.0	1
	06/07/00 03:52	117260	(ML/EPA 900.0)	Alpha, Two Sigma Error	1.7	pCi/l	0.0000	1
	06/07/00 03:52	117260	(ML/EPA 900.0)	Alpha, Min Detectable Activity	1.0	pCi/l	1.0	1
	06/07/00 03:52	117260	(ML/EPA 900.0)	Beta, Gross	9.9	pCi/l	2.1	1
	06/07/00 03:52	117260	(ML/EPA 900.0)	Beta, Two Sigma Error	3.5	pCi/l	0.0000	1
	06/07/00 03:52	117260	(ML/EPA 900.0)	Beta, Min Detectable Activity	2.1	pCi/l	2.1	1

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555 East Walnut Street
Pasadena, California 91101
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Laboratory
QC Summary
#66403

Sierra Environmental Monitoring,
Inc.

QC Batch #117260 - Gross Alpha and Beta RadiationAnalysis Date: 06/07/2000

2005260058 (200005-1066) CW-02-01-000523

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555 East Walnut Street
Pasadena, California 91101
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Laboratory
QC Report
#66403

Sierra Environmental Monitoring,
Inc.

QC Batch #117260 Gross Alpha and Beta Radiation

QC	Analyte	Spiked	Recovered	Yield (%)	Limits (%)	RPD (%)
LCS1	Alpha, Gross	38.9	38.2	98.2	(80.00 - 120.00)	
LCS2	Alpha, Gross	38.9	38.1	97.9	(80.00 - 120.00)	0.26
MS	Alpha, Gross	77.8	85.6	110.0	(80.00 - 120.00)	
LCS1	Beta, Gross	31.9	27.8	87.1	(80.00 - 120.00)	
LCS2	Beta, Gross	31.9	31.3	98.1	(80.00 - 120.00)	12
MS	Beta, Gross	63.8	60.2	94.4	(80.00 - 120.00)	

Spikes which exceed Limits and Method Blanks with positive results are highlighted by Underlining.
Criteria for MS and DUP are advisory only, batch control is based on LCS. Criteria for duplicates are advisory only, unless otherwise specified in the method.

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Pasadena, California 91101
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Laboratory Report

for

Sierra Environmental Monitoring,
Inc.
1135 Financial Blvb.

Reno , NV 89502

Attention: Mike Brisbin
Fax: (775) 857-2404

DATE OF ISSUE
JUN 0 6 2008
MONTGOMERY WATSON LABS

HDS Hillary Strayer

Report#: 66274
DRINKING

Montgomery Watson Laboratories
555 E. Walnut St., Pasadena, CA 91101
PHONE: 626-568-6400/FAX: 626-568-6324

ACKNOWLEDGMENT OF SAMPLES RECEIVED

Sierra Environmental Monitoring, Inc.
1135 Financial Blvb.
Reno, NV 89502
Attn: Mike Brisbin

Customer Code: SIERRAENV
Group#: 66274
Project#: DRINKING
Proj Mgr: Hillary Strayer
Phone: (626) 568-6412

The following samples were received from you on 05/24/00. They have been scheduled for the tests listed beside each sample. If this information is incorrect, please contact your service representative. Thank you for using Montgomery Watson Laboratories.

Sample#	Sample Id	Tests Scheduled	Matrix	Sample Date
2005240059	(200005-1066) CW-02-01523	@RN	Water	05/23/00

Test Acronym Description

Test Acronym	Description
@RN	Radon 222

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Laboratory
Report
#66274

Sierra Environmental Monitoring,
Inc.
Mike Brisbin
1135 Financial Blvb.
Reno , NV 89502

Samples Received

24-may-2000 09:40:00

(200005-1066) CW-02-01523 (2005240059) **Sampled on 05/23/00**

Radon 222

Prepared	Analyzed	QC Batch#	Method	Analyte	Result	Units	MRL	Dilution
	05/25/00	116937	(SM7500RN	) Radon 222	ND	pCi/l	50	1
	05/25/00	116937	(SM7500RN	) Radon 222, Two Sigma Error	NA	pCi/l	0.0000	1

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Laboratory
QC Summary Report
#66274

Sierra Environmental Monitoring,
Inc.

QC Batch #116937 Radon 222 Analysis Date: 05/25/2000

2005240059 (200005-1066) CW-02-01523

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Laboratory
QC Report
#66274

Sierra Environmental Monitoring,
Inc.

QC Batch #116937 Radon 222

QC	Analyte	Spiked	Recovered	Yield (%)	Limits (%)	RPD (%)
LCS1	Radon 222	1000	947	94.7	(80.00 - 120.00)	
LCS2	Radon 222	1000	933	93.3	(80.00 - 120.00)	1.5
MBLK	Radon 222	ND				

Spikes which exceed Limits and Method Blanks with positive results are highlighted by Underlining.
Criteria for MS and DUP are advisory only and not applicable for ICR monitoring.

Sierra Environmental Monitoring, Inc.

Laboratory Analysis Report

City of Fallon
Attn: Paul Strasdin
55 West Williams Ave
Fallon, NV 89406

Date: 7/31/00
Client: FAL-017
Taken by: T.Runnells-Shep
Report: 35182
PO #: 35250

Sample ID:	Customer Sample ID	Date Sampled	Time Sampled	Date Received
S200005-1303	CW-04-01-000526 : #1,2,3,4,7,8,9	5/26/00	8:45 AM	5/26/00

Parameter	Method	Result	Units Of Measure	Detection Limit	Analyst	Date Analyzed
Radium 226 - Radiological	Subcontract	See Report		0		7/28/00

Approved By: _____
Sierra Environmental Monitoring, Inc

Date: _____

This report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report is for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

Final Report

1135 Financial Blvd.
Reno, NV 89502-2348
Phone (775) 857-2400
FAX (775) 857-2404
sem@powernet.net

William F. Pillsbury
President

John Kobza, Ph.D.
John C. Seher
Managers

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
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Laboratory Report

for

Sierra Environmental Monitoring,
Inc.
1135 Financial Blvb.

Reno , NV 89502

Attention: Mike Brisbin
Fax: (775) 857-2404

DATE OF ISSUE
JUL 26 2000
MONTGOMERY WATSON LABS

HDS Hillary Strayer
Project Manager

Report#: 67405
DRINKING

Laboratory certifies that the test results meet all **QA/QC** requirements unless noted in the Comments section or the Case Narrative. Following the cover page are Comments,QC Summary,Data Report, totaling 3 page[s].

Montgomery Watson Laboratories
555 E. Walnut St., Pasadena, CA 91101
PHONE: 626-568-6400/FAX: 626-568-6324

ACKNOWLEDGMENT OF SAMPLES RECEIVED

Sierra Environmental Monitoring, Inc.
1135 Financial Blvb.
Reno, NV 89502
Attn: Mike Brisbin
Phone: (775) 857-2400

Customer Code: SIERRAENV
Group#: 67405
Project#: DRINKING
Proj Mgr: Hillary Strayer
Phone: (626) 568-6412

The following samples were received from you on **06/27/00**. They have been scheduled for the tests listed beside each sample. If this information is incorrect, please contact your service representative. Thank you for using Montgomery Watson Laboratories.

Sample#	Sample Id	Tests Scheduled	Matrix	Sample Date
2006270012	(200005-1303)	CW-04-01-000526 @RA226	Water	26-may-2000

Test Acronym Description

Test Acronym	Description
@RA226	Radium 226 (Sub)

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
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Report
Comments
#67405

(Sample#: 2006270012)
Test: Radium 226 (Sub)
RESULT IS SUBMITTED BY GEL.

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory
Data Report
#67405

Sierra Environmental Monitoring, Inc.
Mike Brisbin
1135 Financial Blvd.
Reno , NV 89502

Samples Received

06/27/00

(200005-1303) CW-04-01-000526 (2006270012) Sampled on 05/26/00 12:00

Radium 226 (Sub)

Prepared	Analyzed	QC Batch#	Method	Analyte	Result	Units	MRL	Dilution
	07/05/00 04:39	120261	(ML/EPA 903.1)	Radium 226	<0.486	pCi/l	0.49	1
	07/05/00 04:39	120261	(EPA 903.1)	Radium 226, Two Sigma Error	NA	pCi/l	0.0000	1
	07/05/00 04:39	120261	(EPA 903)	Radium 226, Minimal Detectable	0.486	pCi/l	0.0000	1

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a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 8324
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Laboratory
QC Summary
#67405

Sierra Environmental Monitoring,
Inc.

QC Batch #120261 - Radium 226 (Sub) **Analysis Date: 07/05/2000**

2006270012 (200005-1303) CW-04-01-000526

Mon... mery Watson Laboratories
555 East Walnut Street
Pasadena, CA 91101
Ph (626) 568-6400 Fax (626) 568-6324

Ship To **Lee Heath**
General Engineering

2040 Savage Road
Charleston, SC 29414

(843) 556-8171 X4433 Fax (843) 766-1178

Date **06/27/00** **Submittal Form** **HDS** .05

Reporting: **One report for this MWL Project Number:** 67405
Do Not Combine Report with any other samples submitted under different MWL project numbers!
Report & Invoice must have the MWL Project Number and Sub PO#: 99-2644
Report all quality control data according to Method. Include dates analyzed, date extracted (if extracted) and Method reference on the report. Fax results to 626-568-6324
Faxed results must have complete data &QC. Hardcopy report is due in hand on due date.
Please advise us immediately if Due Date will be missed. SIERRA NV

HARDCOPY REPORT, FORMS, & INVOICE MUST BE SENT TO ATTENTION
Martha Frost, Sub-contracting Administrator
Montgomery Watson Laboratories 555 East Walnut Street Pasadena, CA 91101
Phone (626) 568-6437 Fax (626) 568-6324

For Specific Questions about samples Hillary Strayer (626) 568-6412

Please provide radiological results for all tests in decimal format with **three decimal places** (not scientific notation) **in Pico Curies per Liter with 2-Sigma Counting Error.**

*****The DRL as defined by the State of California must be reported on the report for all radiological testing. Still need even though samples are for drinking water compliance in the State of Nevada-certification still in effect per Julie Strock/GEL**

MWL Project # 67405 **Report Due:** 07/12/00

Qty	Test Code	Use MWL Lab # for ID	*Client Sample ID for reference only*	Analysis Requested	Sample Date & Time	Matrix	Container
1	@RA226	2006270012	*(200005-1303) CW-04-01-000526*	Radioactivity, Radium 226	05/26/00	dw	1 1L poly + 4ml HNO3 (18%)

Relinquished by: [signature] Sample Control Date 06/27/00 Time [illegible]
Received by: Patricia Dauer Date 6/28/00 Time 09:30 An Acknowledgement of Receipt is requested to attn: Martha Frost

7/21 SIERRAENV 67405

GENERAL ENGINEERING LABORATORIES

Meeting today's needs with a vision for tomorrow.

Certificate of Analysis

Company : Montgomery Laboratories
Address : 555 East Walnut Street
Pasadena, CA 91101

Report Date: July 20, 2000

Contact: Ms. Martha Frost
Project: Routine Analytical

Client Sample ID:	2006270012	Project:	MLAB00195
Sample ID:	27616001	Client ID:	MLAB001
Matrix:	Drinking Water (Potable)		
Collect Date:	26-MAY-00		
Receive Date:	28-JUN-00		
Collector:	Client		

Parameter	Qualifier	Result		DL	RL	Units	DF	AnalystDate	Time	Batch	Method
Rad Radium-226											
Lucas Cell, Ra226, liquid											
Radium-226	U	0.241	+/-0.337	0.486	0.500	pCi/L	1	RDD 07/05/00	1040	32252	1

The following Analytical Methods were performed

Method	Description
1	EPA 903.1

The Qualifiers in this report are defined as follows :

* Indicates that a quality control analyte recovery is outside of specified acceptance criteria.
** Indicates the analyte is a surrogate compound.
< Actual result is less than amount reported
> Actual result is greater than amount reported
J Indicates an estimated value. The result was greater than the detection limit, but less than the reporting limit.
U Indicates the compound was analyzed for but not detected above the detection limit

The above sample is reported on an "as received" basis.

This data report has been prepared and reviewed in accordance with General Engineering Laboratories, Inc. standard operating procedures. Please direct any questions to your Project Manager, Julia Strock at 843-556-8171 Ext. 4247.

Reviewed by

P O Box 30712 • Charleston, SC 29417 • 2040 Savage Road • 29407
(843) 556-8171 • Fax (843) 766-1178

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GENERAL ENGINEERING LABORATORIES

Meeting today's needs with a vision for tomorrow.

QC Summary

Report Date: July 20, 2000
Page 1 of 1

Client : Montgomery Laboratories
555 East Walnut Street
Pasadena, CA 91101

Contact: Ms. Martha Frost

Workorder: 27616

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Rad Radium-226											
Batch 32252											
QC1000072024 27621004 DUP											
Radium-226	U	0.0619 +/-0.272	U	0.463 +/-0.468	pCi/L	153*		(0%-20%)	RDD	07/05/00	12:45
QC1000072025 27583001 DUP											
Radium-226		0.947 +/-0.593		0.883 +/-0.549	pCi/L	7		(0%-20%)			
QC1000072027 LCS											
Radium-226	20.3			17.8 +/-2.18	pCi/L		88	(75%-125%)			
QC1000072023 MB											
Radium-226			U	0.260 +/-0.313	pCi/L					07/05/00	11:40
QC1000072026 27583001 MS											
Radium-226	20.3	0.947 +/-0.593		17.5 +/-2.18	pCi/L		81	(75%-125%)		07/05/00	12:45

Qualifiers in this report are defined as follows:

- * Indicates that a quality control analyte recovery is outside of specified acceptance criteria.
- ** Indicates the analyte is a surrogate compound.
- < Actual result is less than amount reported
- > Actual result is greater than amount reported
- J Indicates an estimated value. The result was greater than the detection limit, but less than the reporting limit.
- U Indicates the compound was analyzed for but not detected above the detection limit

N/A indicates that spike recovery limits do not apply when sample concentration exceeds spike conc. by a factor of 4 or more.
For PS, PSD, and SDILT results, the values listed are the measured amounts, not final concentrations.

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General Engineering Laboratories
Form GEL-XXX
Rev. 02/00)

UNCONTROLLED DOCUMENT

1. NCR Report No.: GEL-AS-RC-2172
2. Page 1 of 1
3. Revision No.: 0

COMPANY-WIDE NONCONFORMANCE REPORT

COMPLETE EVERY ITEM

(See Instructions on Reverse Side)

. Mo. Day Yr.: 7 | 5 | 00

5. Division: ☐ Industrial ☐ Federal ☒ Radiochemistry ☐ Bioassay ☐ Other

6. Type: Material ☐ Process ☐ Product ☒

. Instrument Type: Lucas Cell

8. Quality Criteria: ☒ SOP ☐ QAP or QAPJP ☐ Client Contract ☐ Purchase Document ☐ Drawing ☐ Specifications ☐ Others

. Supplier/Client Name & Code: BHLA, ALSV, LANC, MLAB

10. Test/Method #: A-008

Matrix: Water

1. Numerical Reference Identification: (Batch Number, Sample Number, ID number) 32252

2. Specifications and Requirements Nonconformance Description:

em No.	
1	Calibration has exceeded one year verifications have been run and all were within range.

. Originator's Printed Name & Signature: Ronnie Daves — Date: 7/5/00

14. NRG Disposition:

Item No.	
1.	Reported Data

15. NRG's Printed Name & Signature: Ronnie Daves — Date: 7/5/00

List NRG Participants:

Management Review ☐ or Management Approval ☐

Please review within 24 hours of receipt.

CR Review & Disposition Review or Approval:

. Quality Review: Date

. Originator's Director/Group Leader: Date

Corrective Action Request and Approval:

18. CA Requested: Print Name and Sign — Date

19. Corrective Action Approval & Number — Date

MONTGOMERY WATSON LABORATORIES
a Division of Montgomery Watson Americas, Inc.
555 East Walnut Street
Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
1 800 566 LABS (1 800 566 5227)

Laboratory Report

for

Sierra Environmental Monitoring,
Inc.
1135 Financial Blvb.

Reno , NV 89502

Attention: Mike Brisbin
Fax: (775) 857-2404

DATE OF ISSUE
JUN 1 6 2000
MONTGOMERY WATSON LABS

HDS Hillary Strayer
Project Manager

Report#: 66594
DRINKING

Laboratory certifies that the test results meet all QA/QC requirements unless noted in the Comments section or the Case Narrative. Following the cover page are QC Report,QC Summary,Data Report, totaling 3 page[s].

Montgomery Watson Laboratories
555 E. Walnut St., Pasadena, CA 91101
PHONE: 626-568-6400/FAX: 626-568-6324

ACKNOWLEDGMENT OF SAMPLES RECEIVED

Sierra Environmental Monitoring, Inc.
1135 Financial Blvb.
Reno, NV 89502
Attn: Mike Brisbin

Customer Code: SIERRAENV
PO#: 00-244
Group#: 66594
Project#: DRINKING
Proj Mgr: Hillary Strayer
Phone: (626) 568-6412

The following samples were received from you on 06/01/00. They have been scheduled for the tests listed beside each sample. If this information is incorrect, please contact your service representative. Thank you for using Montgomery Watson Laboratories.

Sample#	Sample Id	Tests Scheduled	Matrix	Sample Date
2006010272	(200005-1303)	CW-04-01-000526 @RAD	Water	05/26/00
2006010273	(200005-1309)	CW-04-03-000526 @RAD	Water	05/26/00

Test Acronym Description

Test Acronym	Description
@RAD	Gross Alpha and Beta Radiation

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Laboratory
Data Report
#66594

Sierra Environmental Monitoring, Inc.
Mike Brisbin
1135 Financial Blvd.
Reno , NV 89502

Samples Received

06/01/00

Prepared	Analyzed	QC Batch#	Method	Analyte	Result	Units	MRL	Dilution
(200005-1303) CW-04-01-000526 (2006010272) Sampled on 05/26/00 08:45								
67405 - Radium 226								
				Gross Alpha and Beta Radiation				
06/14/00	02:17	117725	(ML/EPA 900.0)	Alpha, Gross	6.1	pCi/l	1.0	1
06/14/00	02:17	117725	(ML/EPA 900.0)	Alpha, Two Sigma Error	2.1	pCi/l	0.0000	1
06/14/00	02:17	117725	(ML/EPA 900.0)	Alpha, Min Detectable Activity	1.0	pCi/l	1.0	1
06/14/00	02:17	117725	(ML/EPA 900.0)	Beta, Gross	5.1	pCi/l	1.4	1
06/14/00	02:17	117725	(ML/EPA 900.0)	Beta, Two Sigma Error	2.6	pCi/l	0.0000	1
06/14/00	02:17	117725	(ML/EPA 900.0)	Beta, Min Detectable Activity	1.4	pCi/l	1.4	1
(200005-1309) CW-04-03-000526 (2006010273) Sampled on 05/26/00 10:30								
				Gross Alpha and Beta Radiation				
06/14/00	02:17	117725	(ML/EPA 900.0)	Alpha, Gross	<1.0	pCi/l	1.0	1
06/14/00	02:17	117725	(ML/EPA 900.0)	Alpha, Two Sigma Error	NA	pCi/l	0.0000	1
06/14/00	02:17	117725	(ML/EPA 900.0)	Alpha, Min Detectable Activity	1.0	pCi/l	1.0	1
06/14/00	02:17	117725	(ML/EPA 900.0)	Beta, Gross	<1.2	pCi/l	1.2	1
06/14/00	02:17	117725	(ML/EPA 900.0)	Beta, Two Sigma Error	NA	pCi/l	0.0000	1
06/14/00	02:17	117725	(ML/EPA 900.0)	Beta, Min Detectable Activity	1.2	pCi/l	1.2	1

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Laboratory
QC Summary
#66594

Sierra Environmental Monitoring,
Inc.

QC Batch #117725 - Gross Alpha and Beta RadiationAnalysis Date: 06/14/2000

2006010272	(200005-1303)	CW-04-01-000526
2006010273	(200005-1309)	CW-04-03-000526

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Laboratory
QC Report
#66594

Sierra Environmental Monitoring,
Inc.

QC Batch #117725 Gross Alpha and Beta Radiation

QC	Analyte	Spiked	Recovered	Yield (%)	Limits (%)	RPD (%)
LCS1	Alpha, Gross	38.9	42.3	108.7	(80.00 - 120.00)	
LCS2	Alpha, Gross	38.9	42.9	110.3	(80.00 - 120.00)	1.4
MS	Alpha, Gross	77.8	76.8	98.7	(80.00 - 120.00)	
LCS1	Beta, Gross	31.9	31.7	99.4	(80.00 - 120.00)	
LCS2	Beta, Gross	31.9	31.6	99.1	(80.00 - 120.00)	0.32
MS	Beta, Gross	63.8	57.7	90.4	(80.00 - 120.00)	

Spikes which exceed Limits and Method Blanks with positive results are highlighted by Underlining.
Criteria for MS and DUP are advisory only, batch control is based on LCS. Criteria for duplicates are advisory only, unless otherwise specified in the method.

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Laboratory Report

for

Sierra Environmental Monitoring,
Inc.
1135 Financial Blvb.

Reno , NV 89502

Attention: Mike Brisbin
Fax: (775) 857-2404

DATE OF ISSUE
JUN 1 6 2000
MONTGOMERY WATSON LABS

HDS Hillary Strayer
Project Manager

Report#: 66593
DRINKING

Laboratory certifies that the test results meet all QA/QC requirements unless noted in the Comments section or the Case Narrative. Following the cover page are QC Report,QC Summary,Data Report, totaling 3 page[s].

Montgomery Watson Laboratories
555 E. Walnut St., Pasadena, CA 91101
PHONE: 626-568-6400/FAX: 626-568-6324

ACKNOWLEDGMENT OF SAMPLES RECEIVED

Sierra Environmental Monitoring, Inc.
1135 Financial Blvb.
Reno, NV 89502
Attn: Mike Brisbin

Customer Code: SIERRAENV
PO#: 00-237
Group#: 66593
Project#: DRINKING
Proj Mgr: Hillary Strayer
Phone: (626) 568-6412

The following samples were received from you on 05/31/00. They have been scheduled for the tests listed beside each sample. If this information is incorrect, please contact your service representative. Thank you for using Montgomery Watson Laboratories.

Sample#	Sample Id	Tests Scheduled	Matrix	Sample Date
2006010270	(200005-1156)	NW-01-01-000524 @RAD	Water	05/24/00
2006010271	(200005-1162)	NW-03-01-000524 @RAD	Water	05/24/00

Test Acronym Description

Test Acronym	Description
@RAD	Gross Alpha and Beta Radiation

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Laboratory
Data Report
#66593

Sierra Environmental Monitoring, Inc.
Mike Brisbin
1135 Financial Blvd.
Reno , NV 89502

Samples Received
05/31/00

Prepared	Analyzed	QC Batch#	Method	Analyte	Result	Units	MRL	Dilution
(200005-1156) NW-01-01-000524 (2006010270) Sampled on 05/24/00 12:00								
Gross Alpha and Beta Radiation								
	06/13/00 08:24	117725	(ML/EPA 900.0)	Alpha, Gross	3.0	pCi/l	1.0	1
	06/13/00 08:24	117725	(ML/EPA 900.0)	Alpha, Two Sigma Error	1.6	pCi/l	0.0000	1
	06/13/00 08:24	117725	(ML/EPA 900.0)	Alpha, Min Detectable Activity	1.0	pCi/l	1.0	1
	06/13/00 08:24	117725	(ML/EPA 900.0)	Beta, Gross	8.1	pCi/l	1.9	1
	06/13/00 08:24	117725	(ML/EPA 900.0)	Beta, Two Sigma Error	3.1	pCi/l	0.0000	1
	06/13/00 08:24	117725	(ML/EPA 900.0)	Beta, Min Detectable Activity	1.9	pCi/l	1.9	1
(2[illegible]05-1152) NW-03-01-000524 (2006010271) Sampled on 05/24/00 12:00								
Gross Alpha and Beta Radiation								
	06/14/00 02:17	117725	(ML/EPA 900.0)	Alpha, Gross	1.4	pCi/l	1.0	1
	06/14/00 02:17	117725	(ML/EPA 900.0)	Alpha, Two Sigma Error	1.7	pCi/l	0.0000	1
	06/14/00 02:17	117725	(ML/EPA 900.0)	Alpha, Min Detectable Activity	1.0	pCi/l	1.0	1
	06/14/00 02:17	117725	(ML/EPA 900.0)	Beta, Gross	6.4	pCi/l	1.2	1
	06/14/00 02:17	117725	(ML/EPA 900.0)	Beta, Two Sigma Error	2.4	pCi/l	0.0000	1
	06/14/00 02:17	117725	(ML/EPA 900.0)	Beta, Min Detectable Activity	1.2	pCi/l	1.2	1

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Pasadena, California 91101
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Laboratory
QC Summary
#66593

Sierra Environmental Monitoring,
Inc.

QC Batch #117725 - Gross Alpha and Beta RadiationAnalysis Date: 06/13/2000

2006010270	(200005-1156)	NW-01-01-000524
2006010271	(200005-1162)	NW-03-01-000524

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Laboratory
QC Report
#66593

Sierra Environmental Monitoring,
Inc.

QC Batch #117725 Gross Alpha and Beta Radiation

QC	Analyte	Spiked	Recovered	Yield (%)	Limits (%)	RPD (%)
LCS1	Alpha, Gross	38.9	42.3	108.7	(80.00 - 120.00)	
LCS2	Alpha, Gross	38.9	42.9	110.3	(80.00 - 120.00)	1.4
MS	Alpha, Gross	77.8	76.8	98.7	(80.00 - 120.00)	
LCS1	Beta, Gross	31.9	31.7	99.4	(80.00 - 120.00)	
LCS2	Beta, Gross	31.9	31.6	99.1	(80.00 - 120.00)	0.32
MS	Beta, Gross	63.8	57.7	90.4	(80.00 - 120.00)	

Spikes which exceed Limits and Method Blanks with positive results are highlighted by Underlining.
Criteria for MS and DUP are advisory only, batch control is based on LCS. Criteria for duplicates are advisory only, unless otherwise specified in the method.

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Laboratory Report

for

Sierra Environmental Monitoring,
Inc.
1135 Financial Blvb.

Reno , NV 89502

Attention: Mike Brisbin
Fax: (775) 857-2404

DATE OF ISSUE
JUN 0 6 2000
MONTGOMERY WATSON LABS

HDS Hillary Strayer

Report#: 66398
DRINKING

Montgomery Watson Laboratories
555 E. Walnut St., Pasadena, CA 91101
PHONE: 626-568-6400/FAX: 626-568-6324

ACKNOWLEDGMENT OF SAMPLES RECEIVED

Sierra Environmental Monitoring, Inc.
1135 Financial Blvb.
Reno, NV 89502
Attn: Mike Brisbin
Phone: (775) 857-2400

Customer Code: SIERRAENV
PO#: 00-236
Group#: 66398
Project#: DRINKING
Proj Mgr: Hillary Strayer
Phone: (626) 568-6412

The following samples were received from you on **05/26/00**. They have been scheduled for the tests listed beside each sample. If this information is incorrect, please contact your service representative. Thank you for using Montgomery Watson Laboratories.

Sample#	Sample Id	Tests Scheduled	Matrix	Sample Date
2005260049	(200005-1156)	NW-01-01-000524 @RN	Water	24-may-2000 10:00:00
2005260050	(200005-1162)	NW-01-03-000524 @RN	Water	24-may-2000 10:45:00

Test Acronym Description

Test Acronym	Description
@RN	Radon 222

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Laboratory
Report
#66398

Sierra Environmental Monitoring, Inc.
Mike Brisbin
1135 Financial Blvb.
Reno , NV 89502

Samples Received

26-may-2000 09:30:00

Prepared	Analyzed	QC Batch#	Method	Analyte	Result	Units	MRL	Dilution
(200005-1156) NW-01-01-000524 (2005260049) Sampled on 05/24/00								
			Radon 222					
	05/26/00	116939	(SM7500RN	) Radon 222	93	pCi/l	50	1
	05/26/00	116939	(SM7500RN	) Radon 222, Two Sigma Error	14	pCi/l	0.0000	1
(200005-1162) NW-01-03-000524 (2005260050) Sampled on 05/24/00								
			Radon 222					
	05/26/00	116939	(SM7500RN	) Radon 222	87	pCi/l	50	1
	05/26/00	116939	(SM7500RN	) Radon 222, Two Sigma Error	14	pCi/l	0.0000	1

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a Division of Montgomery Watson Americas, Inc.
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Pasadena, California 91101
Tel: 626 568 6400 Fax: 626 568 6324
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Laboratory
QC Summary Report
#66398

Sierra Environmental Monitoring,
Inc.

QC Batch #116939 - Radon 222 Analysis Date: 05/26/2000

2005260049	(200005-1156)	NW-01-01-000524
2005260050	(200005-1162)	NW-01-03-000524

MONTGOMERY WATSON LABORATORIES
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Pasadena, California 91101
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Laboratory
QC Report
#66398

Sierra Environmental Monitoring,
Inc.

QC Batch #116939 Radon 222

QC	Analyte	Spiked	Recovered	Yield (%)	Limits (%)	RPD (%)
LCS1	Radon 222	1000	948	94.8	(80.00 - 120.00)	
LCS2	Radon 222	1000	908	90.8	(80.00 - 120.00)	4.3
MBLK	Radon 222	ND				

Spikes which exceed Limits and Method Blanks with positive results are highlighted by Underlining.
Criteria for MS and DUP are advisory only and not applicable for ICR monitoring.

SVL ANALYTICAL, INC.
One Government Gulch ■ P.O. Box 929 ■ Kellogg, Idaho 83837-0929 ■ Phone: (208)784-1258 ■ Fax: (208)783-0891

REPORT OF ANALYTICAL RESULTS

Client: Shepherd Miller Inc.

Job No: 94504
Report Date: 6/27/00

Sample ID: CW-01-01-000525
Collected: 5/25/00 8:15 By: TR
Matrix: WATERG

SVL Sample: 233992|233995
Received: 5/26/00

PHYSICAL PROPERTIES	TOTAL	DISSOLVED
pH	9.09	
TDS, mg/L		536
TSS, mg/L	<0.1	
Conductivity		

NONMETALS (mg/L)	TOTAL	DISSOLVED
Alkalinity as CaCO3	201	
Bicarbonate	161	
Carbonate	40.9	
Hydroxide	<1.0	
Chloride	88.7	
Fluoride	0.5	
NO2+NO3-N	0.26	
Orthophosphate		
Sulfate	87.4	

METALS (mg/L)	TOTAL	DISSOLVED
Aluminum	<0.024	
Antimony	<0.001	
Arsenic	0.112	0.106
Barium	<0.002	
Beryllium	<0.002	
Bismuth		
Boron		
Cadmium	<0.0001	
Calcium	1.54	

METALS (cont'd)	TOTAL	DISSOLVED
Chromium	<0.005	<0.005
Cobalt		
Copper	<0.003	
Gallium		
Iron	<0.02	
Lanthanum		
Lead	<0.001	
Lithium		
Magnesium	0.501	
Manganese	<0.002	
Mercury	<0.0002	
Molybdenum		
Nickel	<0.023	
Phosphorus		
Potassium	7.1	
Scandium		
Selenium	<0.001	
Silica	28.1	
Silver	<0.006	
Sodium	196	
Strontium		
Thallium	<0.001	
Tin		
Titanium		
Vanadium		
Zinc	<0.003	

ADDITIONAL TESTS	TOTAL	DISSOLVED
Color	<5.0	
Nitrite-N	<0.25*	
Phosphorus-Total	0.22	
Arsenic - HCl		0.106
As+3 Speciation		<0.002

	TOTAL	DISSOLVED
Turbidity	0.26	
Nitrate-N	0.36	
Arsenic - Unp.	0.110	
Arsenic - AsIII		<0.001
As+5 Speciation		0.102

QUALITY CONTROL

Calculated TDS:	538.2		
Meas/Calc TDS ratio:		Cation-Anion Balance	2.56%
TDS/Cond Ratio:		Cation Sum, meq/L	8.83 0.00
CalcTDS/Cond Ratio:		Anion Sum, meq/L	8.39

*Elevated detection limit due to matrix interference.
AS+3/AS+5= BOTTLE 6
AS-ASIII = BOTTLE 10
AS-HCL = BOTTLE 11 AS-UNP.-BOTTLE 12
This report has been checked and is certified to be accurate.

Signed: Blake Johnson Date: 6/27/00
6/27/00 11:12

SVL ANALYTICAL, INC.
One Government Gulch ■ P.O. Box 929 ■ Kellogg, Idaho 83837-0929 ■ Phone: (208)784-1258 ■ Fax: (208)783-0891

REPORT OF ANALYTICAL RESULTS

Client: Shepherd Miller Inc.

Job No: 94504
Report Date: 6/27/00

Sample ID: CW-01-02-000525
Collected: 5/25/00 8:15 By: TR
Matrix: WATERG

SVL Sample:233993¦233996
Received: 5/26/00

PHYSICAL PROPERTIES	TOTAL	DISSOLVED
pH	9.08	
TDS, mg/L		529
TSS, mg/L	0.4	
Conductivity		

NONMETALS (mg/L)	TOTAL	DISSOLVED
Alkalinity as CaCO3	202	
Bicarbonate	162	
Carbonate	40.0	
Hydroxide	<1.0	
Chloride	89.6	
Fluoride	0.5	
NO2+NO3-N	0.24	
Orthophosphate		
Sulfate	87.8	

METALS (mg/L)	TOTAL	DISSOLVED
Aluminum	<0.024	
Antimony	<0.001	
Arsenic	0.106	0.106
Barium	<0.002	
Beryllium	<0.002	
Bismuth		
Boron		
Cadmium	<0.0001	
Calcium	1.45	

METALS (cont'd)	TOTAL	DISSOLVED
Chromium	<0.005	<0.005
Cobalt		
Copper	<0.003	
Gallium		
Iron	<0.02	
Lanthanum		
Lead	<0.001	
Lithium		
Magnesium	0.463	
Manganese	<0.002	
Mercury	<0.0002	
Molybdenum		
Nickel	<0.023	
Phosphorus		
Potassium	7.1	
Scandium		
Selenium	<0.001	
Silica	26.8	
Silver	<0.006	
Sodium	188	
Strontium		
Thallium	<0.001	
Tin		
Titanium		
Vanadium		
Zinc	<0.003	

ADDITIONAL TESTS	TOTAL	DISSOLVED
Color	<5.0	
Nitrite-N	<0.25*	
Phosphorus-Total	0.22	
Arsenic - HCl		0.100
As+3 Speciation		<0.002

	TOTAL	DISSOLVED
Turbidity	0.47	
Nitrate-N	0.35	
Arsenic - Unp.	0.096	
Arsenic - AsIII		<0.001
As+5 Speciation		0.110

QUALITY CONTROL

Calculated TDS:	530.3		
Meas/Calc TDS ratio:		Cation-Anion Balance	0.12%
TDS/Cond Ratio:		Cation Sum, meq/L	8.47 0.00
CalcTDS/Cond Ratio:		Anion Sum, meq/L	8.45

*Elevated detection limit due to matrix interference.
AS+3/AS+5 = BOTTLE 6
AS-ASIII = BOTTLE 10
AS-HCL = BOTTLE 11 AS-UNP.=BOTTLE 12

This report has been checked and is certified to be accurate.

Signed: Blake Johnson Date: 6/27/00
6/27/00 11:12

SVL ANALYTICAL, INC.
One Government Gulch ■ P.O. Box 929 ■ Kellogg, Idaho 83837-0929 ■ Phone: (208)784-1258 ■ Fax: (208)783-0891

REPORT OF ANALYTICAL RESULTS

Client: Shepherd Miller Inc.

Job No: 94504
Report Date: 6/27/00

Sample ID: CW-03-01-000525
Collected: 5/25/00 13:30 By: TR
Matrix: WATERG

SVL Sample: 233994 | 233997
Received: 5/26/00

PHYSICAL PROPERTIES	TOTAL	DISSOLVED
pH	9.07	
TDS, mg/L		533
TSS, mg/L	1.6	
Conductivity		

NONMETALS (mg/L)	TOTAL	DISSOLVED
Alkalinity as CaCO3	201	
Bicarbonate	161	
Carbonate	40.0	
Hydroxide	<1.0	
Chloride	88.5	
Fluoride	0.5	
NO2+NO3-N	0.25	
Orthophosphate		
Sulfate	89.8	

METALS (mg/L)	TOTAL	DISSOLVED
Aluminum	<0.024	
Antimony	<0.001	
Arsenic	0.110	0.107
Barium	<0.002	
Beryllium	<0.002	
Bismuth		
Boron		
Cadmium	<0.0001	
Calcium	1.45	

METALS (cont'd)	TOTAL	DISSOLVED
Chromium	<0.005	<0.005
Cobalt		
Copper	0.003	
Gallium		
Iron	<0.02	
Lanthanum		
Lead	<0.001	
Lithium		
Magnesium	0.460	
Manganese	<0.002	
Mercury	<0.0002	
Molybdenum		
Nickel	<0.023	
Phosphorus		
Potassium	6.4	
Scandium		
Selenium	<0.001	
Silica	26.5	
Silver	<0.006	
Sodium	184	
Strontium		
Thallium	<0.001	
Tin		
Titanium		
Vanadium		
Zinc	<0.003	

ADDITIONAL TESTS	TOTAL	DISSOLVED
Color	<5.0	
Nitrite-N	<0.25*	
Phosphorus-Total	0.23	
Arsenic - HCl		0.092
As+3 Speciation		<0.002

	TOTAL	DISSOLVED
Turbidity	0.16	
Nitrate-N	0.37	
Arsenic - Unp.	0.116	
Arsenic - AsIII		<0.001
As+5 Speciation		0.102

QUALITY CONTROL

Calculated TDS:	525.7			
Meas/Calc TDS ratio:		Cation-Anion Balance	-1.02%	
TDS/Cond Ratio:		Cation Sum, meq/L	8.27	0.00
CalcTDS/Cond Ratio:		Anion Sum, meq/L	8.44	

*Elevated detection limit due to matrix interference.
AS+3/AS+5 = BOTTLE 6
AS-ASIII = BOTTLE 10
AS-HCL = BOTTLE 11 AS-UNP.= 12

This report has been checked and is certified to be accurate.

Signed: Blake Johnson Date: 6/27/00
6/27/00 11:12

SVL ANALYTICAL, INC. Quality Control Report

Part I Prep Blank and Laboratory Control Sample

ent :Shepherd Miller Inc. SVL JOB No. :94504

Analyte	Method	Matrix	Units	Prep Blank	True—LCS	—Found	LCS %R	Analysis Date
Silver	200.7	WATER	mg/L	<0.006	1.00	0.978	97.8	6/07/00
Aluminum	200.7	WATER	mg/L	<0.024	1.00	0.925	92.5	6/07/00
Barium	200.7	WATER	mg/L	<0.002	1.00	0.963	96.3	6/07/00
Beryllium	200.7	WATER	mg/L	<0.002	1.00	0.952	95.2	6/07/00
Calcium	200.7	WATER	mg/L	0.016	20.0	18.9	94.5	6/07/00
Chromium	200.7	WATER	mg/L	<0.005	1.00	0.925	92.5	6/07/00
Copper	200.7	WATER	mg/L	<0.003	1.00	0.954	95.4	6/07/00
Iron	200.7	WATER	mg/L	<0.02	10.0	9.52	95.2	6/07/00
Potassium	200.7	WATER	mg/L	<1.7	30.0	28.6	95.3	6/07/00
Magnesium	200.7	WATER	mg/L	<0.035	20.0	19.6	98.0	6/07/00
Manganese	200.7	WATER	mg/L	<0.002	1.00	0.950	95.0	6/07/00
Sodium	200.7	WATER	mg/L	<0.088	20.0	19.4	97.0	6/07/00
Nickel	200.7	WATER	mg/L	<0.023	1.00	0.960	96.0	6/07/00
Silica	200.7	WATER	mg/L	<0.17	10.7	9.63	90.0	6/07/00
Zinc	200.7	WATER	mg/L	<0.003	1.00	0.918	91.8	6/07/00
Arsenic	206.2	WATER	mg/L	<0.001	0.050	0.055	110.0	6/05/00
Cadmium	213.2	WATER	mg/L	<0.0001	0.0500	0.0500	100.0	6/05/00
Lead	239.2	WATER	mg/L	<0.001	0.050	0.049	98.0	6/01/00
Antimony	204.2	WATER	mg/L	<0.001	0.050	0.056	112.0	6/01/00
Selenium	270.2	WATER	mg/L	<0.001	0.050	0.042	84.0	6/05/00
Thallium	279.2	WATER	mg/L	<0.001	0.050	0.051	102.0	6/05/00
Mercury	245.1	WATER	mg/L	<0.0002	0.0050	0.0048	96.0	6/06/00
oride	300.0	WATER	mg/L	<0.2	54.2	57.8	106.6	5/26/00
oride	300.0	WATER	mg/L	<0.1	2.3	2.2	95.7	5/26/00
Nitrite-N	300.0	WATER	mg/L	<0.05	3.65	3.81	104.4	5/26/00
Nitrate-N	300.0	WATER	mg/L	<0.05	19.4	19.7	101.5	5/26/00
Sulfate, SO4	300.0	WATER	mg/L	<0.3	19.6	20.9	106.6	5/30/00
Alkalinity,CaCO3	310.1	WATER	mg/L	<1.0	73.0	70.4	96.4	5/31/00
CO3, CaCO3	310.1	WATER	mg/L		N/A		N/A	6/07/00
HCO3, CaCO3	310.1	WATER	mg/L		N/A		N/A	6/07/00
Hydroxide	310.1	WATER	mg/L		N/A		N/A	6/07/00
pH	150.1	WATER		5.22	9.23	9.04	97.9	5/31/00
Arsenic - HCl	206.2	WATER	mg/L	<0.001	0.050	0.055	110.0	6/05/00
Arsenic - AsIII	206.2	WATER	mg/L	<0.001	0.050	0.055	110.0	6/05/00
Arsenic - Unp.	206.2	WATER	mg/L	<0.001	0.050	0.055	110.0	6/05/00
Color	110.3	WATER		<5.0	N/A		N/A	5/31/00
TDS	160.1	WATER	mg/L	<10	337	370	109.8	6/01/00
TSS	160.2	WATER	mg/L	<0.1	42.7	39.8	93.2	6/01/00
As+3 Speciation	APDC	WATER	mg/L	<0.002	0.050	0.054	108.0	5/30/00
As+5 Speciation	DIFF	WATER	mg/L		N/A		N/A	6/07/00
NO2+NO3-N	353.2	WATER	mg/L	<0.02	38.6	38.5	99.7	6/06/00
Phosphorus-Total	365.2	WATER	mg/L	<0.01	7.38	7.52	101.9	6/27/00
Turbidity	180.1	WATER	NTU'S	0.06	1.79	1.84	102.8	5/26/00

LEGEND:

LCS = Laboratory Control Sample LCS %R = LCS Percent Recovery N/A = Not Applicable

6/27/00 11:13

SVL ANALYTICAL, INC. Quality Control Report

Part II Duplicate and Spike Analysis

Client :Shepherd Miller Inc. SVL JOB No :94504

Test	Method	Matrix	QC SAMPLE ID Units	Result	Duplicate Result	RPD%	Matrix Spike Result	SPK ADD	%R	Test Date
Ag	200.7	WATERG 1	mg/L	<0.006	<0.006	UDL	0.970	1.00	97.0	6/07/00
Al	200.7	WATERG 1	mg/L	<0.024	<0.024	UDL	0.929	1.00	92.9	6/07/00
Ba	200.7	WATERG 1	mg/L	<0.002	<0.002	UDL	0.951	1.00	95.1	6/07/00
Be	200.7	WATERG 1	mg/L	<0.002	<0.002	UDL	0.940	1.00	94.0	6/07/00
Ca	200.7	WATERG 1	mg/L	1.54	1.52	1.3	20.1	20.0	92.8	6/07/00
Cr	200.7	WATERG 1	mg/L	<0.005	<0.005	UDL	0.900	1.00	90.0	6/07/00
Cr	200.7	WATERG 2	mg/L	<0.005	<0.005	UDL	0.974	1.00	97.4	6/07/00
Cu	200.7	WATERG 1	mg/L	<0.003	<0.003	UDL	0.943	1.00	94.3	6/07/00
Fe	200.7	WATERG 1	mg/L	<0.02	<0.02	UDL	9.37	10.0	93.7	6/07/00
K	200.7	WATERG 1	mg/L	7.1	6.9	2.9	35.5	30.0	94.7	6/07/00
Mg	200.7	WATERG 1	mg/L	0.501	0.487	2.8	20.0	20.0	97.5	6/07/00
Mn	200.7	WATERG 1	mg/L	<0.002	<0.002	UDL	0.928	1.00	92.8	6/07/00
Na	200.7	WATERG 1	mg/L	196	198	1.0	204	20.0	R >4S	6/07/00
Ni	200.7	WATERG 1	mg/L	<0.023	<0.023	UDL	0.929	1.00	92.9	6/07/00
SiO2	200.7	WATERG 1	mg/L	28.1	28.0	0.4	37.2	10.7	85.0	6/07/00
Zn	200.7	WATERG 1	mg/L	<0.003	<0.003	UDL	0.909	1.00	90.9	6/07/00
As	206.2	WATERG 1	mg/L	0.112	0.109	2.7	0.157	0.0500	90.0	6/05/00
As	206.2	WATERG 2	mg/L	0.106	0.108	1.9	0.153	0.0500	94.0	6/05/00
Cd	213.2	WATERG 1	mg/L	<0.0001	<0.0001	UDL	0.0510	0.0500	102.0	6/05/00
Pb	239.2	WATERG 1	mg/L	<0.001	<0.001	UDL	0.050	0.0500	100.0	6/01/00
Sb	204.2	WATERG 1	mg/L	<0.001	<0.001	UDL	0.059	0.0500	118.0	6/01/00
Se	270.2	WATERG 1	mg/L	<0.001	<0.001	UDL	0.046	0.0500	92.0	6/05/00
Tl	279.2	WATERG 1	mg/L	<0.001	<0.001	UDL	0.056	0.0500	112.0	6/05/00
Hg	245.1	WATERG 1	mg/L	<0.0002	<0.0002	UDL	0.0011	0.0010	110.0	6/06/00
Cl	300.0	WATERG 1	mg/L	88.7	87.9	0.9	140	50.0	102.6	5/26/00
F	300.0	WATERG 1	mg/L	0.5	0.5	0.0	2.6	2.00	105.0	5/26/00
NO2-N	300.0	WATERG 1	mg/L	<0.25*	<0.25*	UDL	9.96	10.0	99.6	5/26/00
NO3-N	300.0	WATERG 1	mg/L	0.36	0.35	2.8	2.50	2.00	107.0	5/26/00
SO4	300.0	WATERG 1	mg/L	87.4	85.4	2.3	193	100	105.6	5/30/00
ALK	310.1	WATERG 1	mg/L	201	204	1.5	N/A	N/A	N/A	5/31/00
CO3	310.1	WATERG 1	mg/L	40.9	42.0	2.7	N/A	N/A	N/A	5/31/00
HCO3	310.1	WATERG 1	mg/L	161	163	1.2	N/A	N/A	N/A	5/31/00
OH	310.1	WATERG 1	mg/L	<1.0	<1.0	UDL	N/A	N/A	N/A	5/31/00
pH	150.1	WATERG 1		9.09	9.09	0.0	N/A	N/A	N/A	5/31/00
As HCl	206.2	WATERG 2	mg/L	0.106	0.094	12.0	0.143	0.0250	R >4S	6/05/00
As III	206.2	WATERG 2	mg/L	<0.001	<0.001	UDL	0.055	0.0500	110.0	6/05/00
As Unp	206.2	WATERG 1	mg/L	0.110	0.094	15.7	0.141	0.0250	124.0	6/05/00
Color	110.3	WATERG 1		<5.0	<5.0	UDL	N/A	N/A	N/A	5/31/00
TDS	160.1	WATERG 2	mg/L	536	540	0.7	N/A	N/A	N/A	6/01/00
TSS	160.2	WATERG 1	mg/L	<0.1	<0.1	UDL	N/A	N/A	N/A	6/01/00
As+3	APDC	WATERG 2	mg/L	<0.002	<0.002	UDL	0.030	0.0250	120.0	5/30/00
As+5	DIFF	WATERG 2	mg/L	0.102	0.101	1.0	N/A	N/A	N/A	6/06/00
NO2NO3	353.2	WATERG 1	mg/L	0.26	0.26	0.0	1.38	1.00	112.0	6/06/00
P-TOT	365.2	WATERG 1	mg/L	0.22	0.22	0.0	0.72	0.500	100.0	6/27/00

LEGEND:

RPD% = (|SAM - DUP|/((SAM + DUP)/2) * 100) M in Duplicate indicates MSD. UDL = Both SAM & DUP not detected.

SPK ADD column, A = Post Digest Spike; %R = Percent Recovery N/A = Not Analyzed; R > 4S = Result more than 4X the Spike Added

QC Sample 1: SVL SAM No.: 233992 Client Sample ID: CW-01-01-000525 ^T

QC Sample 2: SVL SAM No.: 233995 Client Sample ID: CW-01-01-000525 ^D

6/27/00 11:14

SVL ANALYTICAL, INC.

Quality Control Report

Part II Duplicate and Spike Analysis

Client :Shepherd Miller Inc.

SVL JOB No :94504

Test	Method	Matrix	QC SAMPLE ID Units	Result	Duplicate Result	RPD%	Matrix Spike Result	SPK ADD	%R	Test Date
TURB	180.1	WATERG	1 NTU'S	0.26	0.23	12.2	N/A	N/A	N/A	5/26/00

LEGEND:

RPD% = (|SAM - DUP|/((SAM + DUP)/2) * 100) M in Duplicate indicates MSD. UDL = Both SAM & DUP not detected.

SPIKE ADD column, A = Post Digest Spike; %R = Percent Recovery N/A = Not Analyzed; R > 4S = Result more than 4X the Spike Added

QC Sample 1: SVL SAM No.: 233992 Client Sample ID: CW-01-01-000525 ^T

SVL ANALYTICAL, INC.
One Government Gulch ■ P.O. Box 929 ■ Kellogg, Idaho 83837-0929 ■ Phone: (208)784-1258 ■ Fax: (208)783-0891

REPORT OF ANALYTICAL RESULTS

Client: Shepherd Miller Inc.

Job No: 94508
Report Date: 6/27/00

Sample ID: CW-04-01-000526
Collected: 5/26/00 8:45 By: TR
Matrix: WATER

SVL Sample:234064|234066
Received: 5/26/00

PHYSICAL PROPERTIES	TOTAL	DISSOLVED
pH	9.08	
TDS, mg/L		571
TSS, mg/L	0.9	
Conductivity		

NONMETALS (mg/L)	TOTAL	DISSOLVED
Alkalinity as CaCO3	222	
Bicarbonate	177	
Carbonate	45.2	
Hydroxide	<1.0	
Chloride	101	
Fluoride	0.5	
NO2+NO3-N	0.28	
Orthophosphate		
Sulfate	93.2	

METALS (mg/L)	TOTAL	DISSOLVED
Aluminum	<0.024	
Antimony	<0.001	
Arsenic	0.099	0.102
Barium	0.003	
Beryllium	<0.002	
Bismuth		
Boron		
Cadmium	<0.0001	
Calcium	1.31	

METALS (cont'd)	TOTAL	DISSOLVED
Chromium	<0.005	<0.005
Cobalt		
Copper	0.007	
Gallium		
Iron	<0.02	
Lanthanum		
Lead	<0.001	
Lithium		
Magnesium	0.515	
Manganese	<0.002	
Mercury	<0.0002	
Molybdenum		
Nickel	<0.023	
Phosphorus		
Potassium	8.0	
Scandium		
Selenium	<0.001	
Silica	23.8	
Silver	<0.006	
Sodium	189	
Strontium		
Thallium	<0.001	
Tin		
Titanium		
Vanadium		
Zinc	0.003	

ADDITIONAL TESTS	TOTAL	DISSOLVED
Color	<5.0	
Nitrite-N	<0.25*	
Phosphorus-Total	0.22	
Arsenic - HCl		0.107
As+3 Speciation		<0.002

	TOTAL	DISSOLVED
Turbidity	0.08	
Nitrate-N	0.40	
Arsenic - Unp.	0.094	
Arsenic - AsIII		<0.001
As+5 Speciation		0.101

QUALITY CONTROL

Calculated TDS:	557.1		
Meas/Calc TDS ratio:		Cation-Anion Balance	-4.21%
TDS/Cond Ratio:		Cation Sum, meq/L	8.53 0.00
CalcTDS/Cond Ratio:		Anion Sum, meq/L	9.28

*Elevated detection limit due to matrix interference.
AS+3/AS+5=BOTTLE 6
AS-ASIII =BOTTLE 10
AS-HCL =BOTTLE 11 AS-UNP.=BOTTLE 12

This report has been checked and is certified to be accurate.

Signed: Blake Johnson Date: 6/27/00
6/27/00 11:28

SVL ANALYTICAL, INC.
One Government Gulch ■ P.O. Box 929 ■ Kellogg, Idaho 83837-0929 ■ Phone: (208)784-1258 ■ Fax: (208)783-0891

REPORT OF ANALYTICAL RESULTS

Client: Shepherd Miller Inc.

Job No: 94508
Report Date: 6/27/00

Sample ID: CW-04-03-000526
Collected: 5/26/00 10:30 By: TR
Matrix: WATER

SVL Sample:234065|234067
Received: 5/26/00

PHYSICAL PROPERTIES	TOTAL	DISSOLVED
pH	5.95	
TDS, mg/L		<10
TSS, mg/L	<0.1	
Conductivity		

NONMETALS (mg/L)	TOTAL	DISSOLVED
Alkalinity as CaCO3	<1.0	
Bicarbonate	<1.0	
Carbonate	<1.0	
Hydroxide	<1.0	
Chloride	<0.2	
Fluoride	<0.1	
NO2+NO3-N	<0.02	
Orthophosphate		
Sulfate	<0.3	

METALS (mg/L)	TOTAL	DISSOLVED
Aluminum	<0.024	
Antimony	<0.001	
Arsenic	<0.001	<0.001
Barium	<0.002	
Beryllium	<0.002	
Bismuth		
Boron		
Cadmium	<0.0001	
Calcium	0.062	

METALS (cont'd)	TOTAL	DISSOLVED
Chromium	<0.005	<0.005
Cobalt		
Copper	<0.003	
Gallium		
Iron	<0.02	
Lanthanum		
Lead	<0.001	
Lithium		
Magnesium	0.048	
Manganese	<0.002	
Mercury	<0.0002	
Molybdenum		
Nickel	<0.023	
Phosphorus		
Potassium	<1.7	
Scandium		
Selenium	<0.001	
Silica	<0.17	
Silver	<0.006	
Sodium	<0.088	
Strontium		
Thallium	<0.001	
Tin		
Titanium		
Vanadium		
Zinc	<0.003	

ADDITIONAL TESTS	TOTAL	DISSOLVED
Color	<5.0	
Nitrite-N	<0.05	
Phosphorus-Total	<0.01	
Arsenic - HCl		<0.001
As+3 Speciation		<0.002

	TOTAL	DISSOLVED
Turbidity	0.11	
Nitrate-N	<0.05	
Arsenic - Unp.	<0.001	
Arsenic - AsIII		<0.001
As+5 Speciation		<0.002

QUALITY CONTROL

Calculated TDS:	0.1		
Meas/Calc TDS ratio:		Cation-Anion Balance	N/A %
TDS/Cond Ratio:		Cation Sum, meq/L	0.00 0.00
CalcTDS/Cond Ratio:		Anion Sum, meq/L	<0.01

AS+3/AS+5=BOTTLE 6
AS-ASIII =BOTTLE 10
AS-HCL =BOTTLE 11 AS-UNP.=BOTTLE 12

This report has been checked and is certified to be accurate.

Signed: Blake Johnson Date: 6/27/00
6/27/00 11:28

SVL ANALYTICAL, INC.

Quality Control Report

Part I Prep Blank and Laboratory Control Sample

Client :Shepherd Miller Inc.

SVL JOB No. :94508

Analyte	Method	Matrix	Units	Prep Blank	True—LCS—Found		LCS %R	Analysis Date
Silver	200.7	WATER	mg/L	<0.006	1.00	0.990	99.0	6/08/00
Aluminum	200.7	WATER	mg/L	<0.024	1.00	0.946	94.6	6/08/00
Barium	200.7	WATER	mg/L	<0.002	1.00	0.976	97.6	6/08/00
Beryllium	200.7	WATER	mg/L	<0.002	1.00	0.922	92.2	6/08/00
Calcium	200.7	WATER	mg/L	0.016	20.0	19.3	96.5	6/08/00
Chromium	200.7	WATER	mg/L	<0.005	1.00	0.928	92.8	6/08/00
Copper	200.7	WATER	mg/L	<0.003	1.00	0.963	96.3	6/08/00
Iron	200.7	WATER	mg/L	<0.02	10.0	9.75	97.5	6/08/00
Potassium	200.7	WATER	mg/L	<1.7	30.0	29.5	98.3	6/08/00
Magnesium	200.7	WATER	mg/L	<0.035	20.0	19.9	99.5	6/08/00
Manganese	200.7	WATER	mg/L	<0.035	1.00	0.961	96.1	6/08/00
Sodium	200.7	WATER	mg/L	<0.088	20.0	19.4	97.0	6/08/00
Nickel	200.7	WATER	mg/L	<0.023	1.00	0.918	91.8	6/08/00
Silica	200.7	WATER	mg/L	<0.17	10.7	9.53	89.1	6/08/00
Zinc	200.7	WATER	mg/L	<0.003	1.00	0.919	91.9	6/08/00
Arsenic	206.2	WATER	mg/L	<0.001	0.050	0.051	102.0	6/07/00
Cadmium	213.2	WATER	mg/L	<0.0001	0.0500	0.0490	98.0	6/07/00
Lead	239.2	WATER	mg/L	<0.001	0.050	0.049	98.0	6/07/00
Antimony	204.2	WATER	mg/L	<0.001	0.050	0.056	112.0	6/07/00
Selenium	270.2	WATER	mg/L	<0.001	0.050	0.047	94.0	6/07/00
Thallium	279.2	WATER	mg/L	<0.001	0.050	0.049	98.0	6/07/00
Mercury	245.1	WATER	mg/L	<0.0002	0.0050	0.0050	100.0	6/07/00
Chloride	300.0	WATER	mg/L	<0.2	54.2	57.6	106.3	5/27/00
Fluoride	300.0	WATER	mg/L	<0.1	2.3	2.2	95.7	5/27/00
Nitrite-N	300.0	WATER	mg/L	<0.05	3.65	3.83	104.9	5/27/00
Nitrate-N	300.0	WATER	mg/L	<0.05	19.4	19.9	102.6	5/27/00
Sulfate, SO4	300.0	WATER	mg/L	<0.3	19.6	21.1	107.7	5/27/00
Alkalinity,CaCO3	310.1	WATER	mg/L	<1.0	73.0	74.4	101.9	6/02/00
CO3, CaCO3	310.1	WATER	mg/L		N/A		N/A	6/08/00
HCO3, CaCO3	310.1	WATER	mg/L		N/A		N/A	6/08/00
Hydroxide	310.1	WATER	mg/L		N/A		N/A	6/08/00
pH	150.1	WATER		5.70	9.23	9.03	97.8	6/02/00
Arsenic - HCl	206.2	WATER	mg/L	<0.001	0.050	0.051	102.0	6/07/00
Arsenic - AsIII	206.2	WATER	mg/L	<0.001	0.050	0.051	102.0	6/07/00
Arsenic - Unp.	206.2	WATER	mg/L	<0.001	0.050	0.051	102.0	6/07/00
Color	110.3	WATER		<5.0	N/A		N/A	5/31/00
TDS	160.1	WATER	mg/L	<10	337	302	89.6	6/02/00
TSS	160.2	WATER	mg/L	<0.1	50.3	44.0	87.5	6/02/00
As+3 Speciation	APDC	WATER	mg/L	<0.002	0.050	0.054	108.0	5/30/00
As+5 Speciation	DIFF	WATER	mg/L		N/A		N/A	6/08/00
NO2+NO3-N	353.2	WATER	mg/L	<0.02	38.6	38.5	99.7	6/06/00
Phosphorus-Total	365.2	WATER	mg/L	<0.01	7.38	7.52	101.9	6/27/00
Turbidity	180.1	WATER	NTU'S	0.06	1.79	1.80	100.6	5/27/00

LEGEND:

LCS = Laboratory Control Sample LCS %R = LCS Percent Recovery N/A = Not Applicable

6/27/00 11:26

SVL ANALYTICAL, INC. Quality Control Report

Part II Duplicate and Spike Analysis

Client :Shepherd Miller Inc. SVL JOB No :94508

Test	Method	Matrix	QC SAMPLE ID Units	Result	Duplicate Result	RPD%	Matrix Spike Result	SPK ADD	%R	Test Date
Ag	200.7	WATER	1 mg/L	<0.006	<0.006	UDL	0.967	1.00	96.7	6/08/00
Al	200.7	WATER	1 mg/L	<0.024	<0.024	UDL	0.929	1.00	92.9	6/08/00
Ba	200.7	WATER	1 mg/L	0.003	0.003	0.0	0.940	1.00	93.7	6/08/00
Be	200.7	WATER	1 mg/L	<0.002	<0.002	UDL	0.883	1.00	88.3	6/08/00
Ca	200.7	WATER	1 mg/L	1.31	1.44	9.5	19.8	20.0	92.5	6/08/00
Cr	200.7	WATER	1 mg/L	<0.005	<0.005	UDL	0.886	1.00	88.6	6/08/00
Cr	200.7	WATER	2 mg/L	<0.005	<0.005	UDL	0.968	1.00	96.8	6/08/00
Cu	200.7	WATER	1 mg/L	0.007	0.005	33.3	0.939	1.00	93.2	6/08/00
Fe	200.7	WATER	1 mg/L	<0.02	<0.02	UDL	9.28	10.0	92.8	6/08/00
K	200.7	WATER	1 mg/L	8.0	7.2	10.5	36.6	30.0	95.3	6/08/00
Mg	200.7	WATER	1 mg/L	0.515	0.564	9.1	19.9	20.0	96.9	6/08/00
Mn	200.7	WATER	1 mg/L	<0.002	<0.002	UDL	0.920	1.00	92.0	6/08/00
Na	200.7	WATER	1 mg/L	189	180	4.9	212	20.0	115.0	6/08/00
Ni	200.7	WATER	1 mg/L	<0.023	<0.023	UDL	0.878	1.00	87.8	6/08/00
SiO2	200.7	WATER	1 mg/L	23.8	25.7	7.7	35.3	10.7	107.5	6/08/00
Zn	200.7	WATER	1 mg/L	0.003	<0.003	200.0	0.894	1.00	89.1	6/08/00
As	206.2	WATER	1 mg/L	0.099	0.102	3.0	0.151	0.0500	104.0	6/07/00
As	206.2	WATER	2 mg/L	0.102	0.098	4.0	0.163	0.0500	122.0	6/07/00
Cd	213.2	WATER	1 mg/L	<0.0001	<0.0001	UDL	0.0540	0.0500	108.0	6/07/00
Pb	239.2	WATER	1 mg/L	<0.001	<0.001	UDL	0.046	0.0500	92.0	6/07/00
Sb	204.2	WATER	1 mg/L	<0.001	<0.001	UDL	0.058	0.0500	116.0	6/07/00
Se	270.2	WATER	1 mg/L	<0.001	<0.001	UDL	0.051	0.0500	102.0	6/07/00
Tl	279.2	WATER	1 mg/L	<0.001	<0.001	UDL	0.050	0.0500	100.0	6/07/00
Hg	245.1	WATER	1 mg/L	<0.0002	<0.0002	UDL	0.0010	0.0010	100.0	6/07/00
Cl	300.0	WATER	1 mg/L	101	102	1.0	155	50.0	108.0	5/27/00
F	300.0	WATER	1 mg/L	0.5	0.5	0.0	2.6	2.00	105.0	5/27/00
NO2-N	300.0	WATER	1 mg/L	<0.25*	<0.25*	UDL	10.7	10.0	107.0	5/27/00
NO3-N	300.0	WATER	1 mg/L	0.40	0.40	0.0	2.42	2.00	101.0	5/27/00
SO4	300.0	WATER	1 mg/L	93.2	92.9	0.3	146	50.0	105.6	5/27/00
ALK	310.1	WATER	1 mg/L	222	221	0.5	N/A	N/A	N/A	6/02/00
CO3	310.1	WATER	1 mg/L	45.2	44.8	0.9	N/A	N/A	N/A	6/02/00
HCO3	310.1	WATER	1 mg/L	177	177	0.0	N/A	N/A	N/A	6/02/00
OH	310.1	WATER	1 mg/L	<1.0	<1.0	UDL	N/A	N/A	N/A	6/02/00
pH	150.1	WATER	1	9.08	9.08	0.0	N/A	N/A	N/A	6/02/00
As HCl	206.2	WATER	2 mg/L	0.107	0.102	4.8	0.148	0.0500	82.0	6/07/00
As III	206.2	WATER	2 mg/L	<0.001	<0.001	UDL	0.049	0.0500	98.0	6/07/00
As Unp	206.2	WATER	1 mg/L	0.094	0.091	3.2	0.148	0.0500	108.0	6/07/00
Color	110.3	WATER	1	<5.0	<5.0	UDL	N/A	N/A	N/A	5/31/00
TDS	160.1	WATER	2 mg/L	571	570	0.2	N/A	N/A	N/A	6/02/00
TSS	160.2	WATER	1 mg/L	0.9	0.9	0.0	N/A	N/A	N/A	6/02/00
As+3	APDC	WATER	2 mg/L	<0.002	<0.002	UDL	0.027	0.0250	108.0	5/30/00
As+5	DIFF	WATER	2 mg/L	0.101	0.099	2.0	N/A	N/A	N/A	6/08/00
NO2NO3	353.2	WATER	1 mg/L	0.28	0.28	0.0	1.40	1.00	112.0	6/06/00
P-TOT	365.2	WATER	1 mg/L	0.22	0.22	0.0	0.73	0.500	102.0	6/27/00

LEGEND:

RPD% = (|SAM - DUP|/((SAM + DUP)/2) * 100) M in Duplicate indicates MSD. UDL = Both SAM & DUP not detected.

SPIKE ADD column, A = Post Digest Spike; %R = Percent Recovery N/A = Not Analyzed; R > 4S = Result more than 4X the Spike Added

Sample 1: SVL SAM No.: 234064 Client Sample ID: CW-04-01-000526 ^T

QC Sample 2: SVL SAM No.: 234066 Client Sample ID: CW-04-01-000526 ^D

6/27/00 11:27

SVL ANALYTICAL, INC.

Quality Control Report

Part II Duplicate and Spike Analysis

Client :Shepherd Miller Inc.

SVL JOB No :94508

Test	Method	Matrix	QC SAMPLE ID		Duplicate		Matrix Spike			Test
			Units	Result	Result	RPD%	Result	SPK ADD	%R	Date
TURB	180.1	WATER	1 NTU'S	0.08	0.08	0.0	N/A	N/A	N/A	5/27/00

LEGEND:

RPD% = (|SAM - DUP|/((SAM + DUP)/2) * 100) M in Duplicate indicates MSD. UDL = Both SAM & DUP not detected.

SPIKE ADD column, A = Post Digest Spike; %R = Percent Recovery N/A = Not Analyzed; R > 4S = Result more than 4X the Spike Added

QC Sample 1: SVL SAM No.: 234064 Client Sample ID: CW-04-01-000526 ^T

6/27/00 11:27

SVL ANALYTICAL, INC.
One Government Gulch ■ P.O. Box 929 ■ Kellogg, Idaho 83837-0929 ■ Phone: (208)784-1258 ■ Fax: (208)783-0891

REPORT OF ANALYTICAL RESULTS

Client: Shepherd Miller Inc.

Job No: 94467
Report Date: 6/27/00

Sample ID: CW-02-01-000523
Collected: 5/23/00 9:30 By: TR
Matrix: WATERG

SVL Sample: 233647 | 233648
Received: 5/24/00

PHYSICAL PROPERTIES	TOTAL	DISSOLVED
pH	8.97	
TDS, mg/L		538
TSS, mg/L	<0.1	
Conductivity		

NONMETALS (mg/L)	TOTAL	DISSOLVED
Alkalinity as CaCO3	223	
Bicarbonate	176	
Carbonate	45.0	
Hydroxide	<1.0	
Chloride	87.1	
Fluoride	0.5	
NO2+NO3-N	<0.02	
Orthophosphate		
Sulfate	90.4	

METALS (mg/L)	TOTAL	DISSOLVED
Aluminum	<0.024	
Antimony	<0.001	
Arsenic	0.096	0.099
Barium	<0.002	
Beryllium	<0.002	
Bismuth		
Boron		
Cadmium	<0.0001	
Calcium	1.17	

METALS (cont'd)	TOTAL	DISSOLVED
Chromium	<0.005	<0.005
Cobalt		
Copper	<0.003	
Gallium		
Iron	<0.02	
Lanthanum		
Lead	0.001	
Lithium		
Magnesium	0.525	
Manganese	<0.002	
Mercury	<0.0002	
Molybdenum		
Nickel	<0.023	
Phosphorus		
Potassium	8.3	
Scandium		
Selenium	<0.001	
Silica	26.9	
Silver	<0.006	
Sodium	202	
Strontium		
Thallium	<0.001	
Tin		
Titanium		
Vanadium		
Zinc	<0.003	

ADDITIONAL TESTS	TOTAL	DISSOLVED		TOTAL	DISSOLVED
Color	<5.0		Turbidity	0.07	
Nitrite-N	<0.25*		Nitrate-N	0.37	
Phosphorus-Total	0.22		Arsenic - Unp.	0.114	
Arsenic - Hcl		0.110	Arsenic - AsIII		<0.001
As+3 Speciation		<0.002	As+5 Speciation		0.094

QUALITY CONTROL

Calculated TDS:	557.9			
Meas/Calc TDS ratio:		Cation-Anion Balance	1.51%	
TDS/Cond Ratio:		Cation Sum, meq/L	9.10	0.00
CalcTDS/Cond Ratio:		Anion Sum, meq/L	8.83	

*Elevated detection limit due to matrix interference.
AS+3/AS+5=BOTTLE 6
AS-ASIII =BOTTLE 10
AS-HCL =BOTTLE 11 AS-UNP.=BOTTLE 12

This report has been checked and is certified to be accurate.

Signed: Blake Johnson Date: 6/27/00
6/27/00 11:06

SVL ANALYTICAL, INC. Quality Control Report

Part I Prep Blank and Laboratory Control Sample

Client :Shepherd Miller Inc. SVL JOB No. :94467

Analyte	Method	Matrix	Units	Prep Blank	True—LCS—Found		LCS %R	Analysis Date
Silver	200.7	WATER	mg/L	<0.006	1.00	0.969	96.9	6/01/00
Aluminum	200.7	WATER	mg/L	<0.024	1.00	0.946	94.6	6/01/00
Barium	200.7	WATER	mg/L	<0.002	1.00	0.954	95.4	6/01/00
Beryllium	200.7	WATER	mg/L	<0.002	1.00	0.997	99.7	6/01/00
Calcium	200.7	WATER	mg/L	<0.013	20.0	18.6	93.0	6/01/00
Chromium	200.7	WATER	mg/L	<0.005	1.00	0.941	94.1	6/01/00
Copper	200.7	WATER	mg/L	<0.003	1.00	0.952	95.2	6/01/00
Iron	200.7	WATER	mg/L	<0.02	10.0	9.69	96.9	6/01/00
Potassium	200.7	WATER	mg/L	<1.7	30.0	28.2	94.0	6/01/00
Magnesium	200.7	WATER	mg/L	<0.035	20.0	19.5	97.5	6/01/00
Manganese	200.7	WATER	mg/L	<0.002	1.00	0.937	93.7	6/01/00
Sodium	200.7	WATER	mg/L	<0.088	20.0	19.4	97.0	6/01/00
Nickel	200.7	WATER	mg/L	<0.023	1.00	0.936	93.6	6/01/00
Silica	200.7	WATER	mg/L	0.45	10.7	10.4	97.2	6/01/00
Zinc	200.7	WATER	mg/L	<0.003	1.00	0.952	95.2	6/01/00
Arsenic	206.2	WATER	mg/L	<0.001	0.050	0.049	98.0	5/31/00
Cadmium	213.2	WATER	mg/L	<0.0001	0.0500	0.0530	106.0	6/01/00
Lead	239.2	WATER	mg/L	<0.001	0.050	0.050	100.0	5/31/00
Antimony	204.2	WATER	mg/L	<0.001	0.050	0.049	98.0	5/31/00
Selenium	270.2	WATER	mg/L	<0.001	0.050	0.045	90.0	5/31/00
Thallium	279.2	WATER	mg/L	<0.001	0.050	0.055	110.0	6/01/00
Mercury	245.1	WATER	mg/L	<0.0002	0.0050	0.0052	104.0	6/02/00
[illegible]oride	300.0	WATER	mg/L	<0.2	54.2	56.4	104.1	5/24/00
[illegible]oride	300.0	WATER	mg/L	<0.1	2.3	2.2	95.7	5/24/00
Nitrite-N	300.0	WATER	mg/L	<0.05	3.65	3.74	102.5	5/24/00
Nitrate-N	300.0	WATER	mg/L	<0.05	19.4	19.6	101.0	5/24/00
Sulfate, SO4	300.0	WATER	mg/L	<0.3	19.6	20.7	105.6	5/24/00
Alkalinity,CaCO3	310.1	WATER	mg/L	<1.0	73.0	74.4	101.9	6/02/00
CO3, CaCO3	310.1	WATER	mg/L		N/A		N/A	6/04/00
HCO3, CaCO3	310.1	WATER	mg/L		N/A		N/A	6/04/00
Hydroxide	310.1	WATER	mg/L		N/A		N/A	6/04/00
pH	150.1	WATER		5.70	9.23	9.03	97.8	6/02/00
Arsenic - HCl	206.2	WATER	mg/L	<0.001	0.050	0.050	100.0	5/31/00
Arsenic - AsIII	206.2	WATER	mg/L	<0.001	0.050	0.050	100.0	5/31/00
Arsenic - Unp.	206.2	WATER	mg/L	<0.001	0.050	0.050	100.0	5/31/00
Color	110.3	WATER		<5.0	N/A		N/A	5/25/00
TDS	160.1	WATER	mg/L	<10	231	256	110.8	5/25/00
TSS	160.2	WATER	mg/L	<0.1	42.7	37.2	87.1	5/25/00
As+3 Speciation	APDC	WATER	mg/L	0.002	0.050	0.055	110.0	5/26/00
As+5 Speciation	DIFF	WATER	mg/L		N/A		N/A	5/31/00
NO2+NO3-N	353.2	WATER	mg/L	<0.02	38.6	35.7	92.5	5/26/00
Phosphorus-Total	365.2	WATER	mg/L	<0.01	7.38	7.52	101.9	6/27/00
Turbidity	180.1	WATER	NTU'S	0.07	13.6	13.3	97.8	5/24/00

LEGEND:

LCS = Laboratory Control Sample LCS %R = LCS Percent Recovery N/A = Not Applicable

6/27/00 11:08

SVL ANALYTICAL, INC.

Quality Control Report

Part II Duplicate and Spike Analysis

Client :Shepherd Miller Inc. SVL JOB No :94467

Test	Method	Matrix	QC SAMPLE ID Units	Result	Duplicate Result	RPD%	Matrix Spike Result	SPK ADD	%R	Test Date
Ag	200.7	WATERG 1	mg/L	<0.006	<0.006	UDL	0.979	1.00	97.9	6/01/00
Al	200.7	WATERG 1	mg/L	<0.024	<0.024	UDL	0.989	1.00	98.9	6/01/00
Ba	200.7	WATERG 1	mg/L	<0.002	<0.002	UDL	0.971	1.00	97.1	6/01/00
Be	200.7	WATERG 1	mg/L	<0.002	<0.002	UDL	1.01	1.00	101.0	6/01/00
Ca	200.7	WATERG 1	mg/L	1.17	1.54	27.3	21.0	20.0	99.2	6/01/00
Cr	200.7	WATERG 1	mg/L	<0.005	<0.005	UDL	0.938	1.00	93.8	6/01/00
Cr	200.7	WATERG 2	mg/L	<0.005	<0.005	UDL	0.983	1.00	98.3	6/01/00
Cu	200.7	WATERG 1	mg/L	<0.003	<0.003	UDL	0.970	1.00	97.0	6/01/00
Fe	200.7	WATERG 1	mg/L	<0.02	<0.02	UDL	9.72	10.0	97.2	6/01/00
K	200.7	WATERG 1	mg/L	8.3	8.1	2.4	29.1	30.0	69.3	6/01/00
Mg	200.7	WATERG 1	mg/L	0.525	0.570	8.2	21.1	20.0	102.9	6/01/00
Mn	200.7	WATERG 1	mg/L	<0.002	<0.002	UDL	0.935	1.00	93.5	6/01/00
Na	200.7	WATERG 1	mg/L	202	202	0.0	218	20.0	80.0	6/01/00
Ni	200.7	WATERG 1	mg/L	<0.023	<0.023	UDL	0.942	1.00	94.2	6/01/00
SiO2	200.7	WATERG 1	mg/L	26.9	27.8	3.3	37.1	10.7	95.3	6/01/00
Zn	200.7	WATERG 1	mg/L	<0.003	<0.003	UDL	0.958	1.00	95.8	6/01/00
As	206.2	WATERG 1	mg/L	0.096	0.102	6.1	0.141	0.0500	90.0	5/31/00
As	206.2	WATERG 2	mg/L	0.099	0.093	6.3	0.146	0.0500	94.0	5/31/00
Cd	213.2	WATERG 1	mg/L	<0.0001	<0.0001	UDL	0.0470	0.0500	94.0	6/01/00
Pb	239.2	WATERG 1	mg/L	0.001	0.001	0.0	0.049	0.0500	96.0	5/31/00
Sb	204.2	WATERG 1	mg/L	<0.001	<0.001	UDL	0.055	0.0500	110.0	5/31/00
Se	270.2	WATERG 1	mg/L	<0.001	<0.001	UDL	0.052	0.0500	104.0	5/31/00
Tl	279.2	WATERG 1	mg/L	<0.001	<0.001	UDL	0.054	0.0500	108.0	6/01/00
Hg	245.1	WATERG 1	mg/L	<0.0002	<0.0002	UDL	0.0011	0.0010	110.0	6/02/00
Cl	300.0	WATERG 1	mg/L	87.1	86.1	1.2	139	50.0	103.8	5/24/00
F	300.0	WATERG 1	mg/L	0.5	0.6	18.2	2.6	2.00	105.0	5/24/00
NO2-N	300.0	WATERG 1	mg/L	<0.25*	<0.25*	UDL	9.90	10.0	99.0	5/24/00
NO3-N	300.0	WATERG 1	mg/L	0.37	0.38	2.7	2.37	2.00	100.0	5/24/00
SO4	300.0	WATERG 1	mg/L	90.4	90.7	0.3	143	50.0	105.2	5/24/00
ALK	310.1	WATERG 1	mg/L	223	225	0.9	N/A	N/A	N/A	6/02/00
CO3	310.1	WATERG 1	mg/L	45.0	43.0	4.5	N/A	N/A	N/A	6/02/00
HCO3	310.1	WATERG 1	mg/L	176	180	2.2	N/A	N/A	N/A	6/02/00
OH	310.1	WATERG 1	mg/L	<1.0	<1.0	UDL	N/A	N/A	N/A	6/02/00
pH	150.1	WATERG 1		8.97	8.96	0.1	N/A	N/A	N/A	6/02/00
As HCl	206.2	WATERG 2	mg/L	0.110	0.094	15.7	0.151	0.0500	82.0	5/31/00
As III	206.2	WATERG 2	mg/L	<0.001	<0.001	UDL	0.064	0.0500	128.0	5/31/00
As Unp	206.2	WATERG 1	mg/L	0.114	0.123	7.6	0.162	0.0500	96.0	5/31/00
Color	110.3	WATERG 1		<5.0	<5.0	UDL	N/A	N/A	N/A	5/25/00
TDS	160.1	WATERG 2	mg/L	538	533	0.9	N/A	N/A	N/A	5/25/00
TSS	160.2	WATERG 1	mg/L	<0.1	<0.1	UDL	N/A	N/A	N/A	5/25/00
As+3	APDC	WATERG 2	mg/L	<0.002	<0.002	UDL	0.028	0.0250	112.0	5/26/00
As+5	DIFF	WATERG 2	mg/L	0.094	0.107	12.9	N/A	N/A	N/A	5/31/00
NO2NO3	353.2	WATERG 1	mg/L	<0.02	<0.02	UDL	1.24	1.00	124.0	5/26/00
P-TOT	365.2	WATERG 1	mg/L	0.22	0.22	0.0	0.73	0.500	102.0	6/27/00

LEGEND:

RPD% = (|SAM - DUP|/((SAM + DUP)/2) * 100) M in Duplicate indicates MSD. UDL = Both SAM & DUP not detected.

SPK ADD column, A = Post Digest Spike; %R = Percent Recovery N/A = Not Analyzed; R > 4S = Result more than 4X the Spike Added

QC Sample 1: SVL SAM No.: 233647 Client Sample ID: CW-02-01-000523 ^T

QC Sample 2: SVL SAM No.: 233648 Client Sample ID: CW-02-01-000523 ^D

6/27/00 11:08

SVL ANALYTICAL, INC. Quality Control Report

Part II Duplicate and Spike Analysis

Client :Shepherd Miller Inc. SVL JOB No :94467

Test	Method	Matrix	QC SAMPLE ID Units	Result	Duplicate Result	RPD%	Matrix Spike Result	SPK ADD	%R	Test Date
TURB	180.1	WATERG 1	NTU'S	0.07	0.06	15.4	N/A	N/A	N/A	5/24/00

LEGEND:

RPD% = (|SAM - DUP|/((SAM + DUP)/2) * 100) M in Duplicate indicates MSD. UDL = Both SAM & DUP not detected.

SPIKE ADD column, A = Post Digest Spike; %R = Percent Recovery N/A = Not Analyzed; R > 4S = Result more than 4X the Spike Added

QC Sample 1: SVL SAM No.: 233647 Client Sample ID: CW-02-01-000523 ^T

SVL ANALYTICAL, INC.
One Government Gulch ■ P.O. Box 929 ■ Kellogg, Idaho 83837-0929 ■ Phone: (208)784-1258 ■ Fax: (208)783-0891

REPORT OF ANALYTICAL RESULTS

Client: Shepherd Miller Inc.

Job No: 94485
Report Date: 6/27/00

Sample ID: NW-01-01-000524
Collected: 5/24/00 10:00 By: TR
Matrix: WATERG

SVL Sample:233785|233787
Received: 5/25/00

PHYSICAL PROPERTIES	TOTAL	DISSOLVED
pH	9.04	
TDS, mg/L		581
TSS, mg/L	0.5	
Conductivity		

NONMETALS (mg/L)	TOTAL	DISSOLVED
Alkalinity as CaCO3	221	
Bicarbonate	178	
Carbonate	42.3	
Hydroxide	<1.0	
Chloride	115	
Fluoride	0.5	
NO2+NO3-N	0.30	
Orthophosphate		
Sulfate	100	

METALS (mg/L)	TOTAL	DISSOLVED
Aluminum	<0.024	
Antimony	<0.001	
Arsenic	0.119	0.126
Barium	<0.002	
Beryllium	<0.002	
Bismuth		
Boron		
Cadmium	<0.0001	
Calcium	1.25	

METALS (cont'd)	TOTAL	DISSOLVED
Chromium	<0.005	<0.005
Cobalt		
Copper	0.007	
Gallium		
Iron	0.02	
Lanthanum		
Lead	<0.001	
Lithium		
Magnesium	0.452	
Manganese	<0.002	
Mercury	<0.0002	
Molybdenum		
Nickel	<0.023	
Phosphorus		
Potassium	7.4	
Scandium		
Selenium	<0.001	
Silica	24.0	
Silver	<0.006	
Sodium	215	
Strontium		
Thallium	<0.001	
Tin		
Titanium		
Vanadium		
Zinc	0.009	

ADDITIONAL TESTS	TOTAL	DISSOLVED		TOTAL	DISSOLVED
Color	<5.0		Turbidity	0.42	
Nitrite-N	<0.25*		Nitrate-N	0.50	
Phosphorus-Total	0.24		Arsenic - Unp.	0.090	
Arsenic - HCl		0.114	Arsenic - AsIII		<0.001
As+3 Speciation		<0.002	As+5 Speciation		0.104

QUALITY CONTROL

Calculated TDS:	603.0				
Meas/Calc TDS ratio:			Cation-Anion Balance	-0.77%	
TDS/Cond Ratio:			Cation Sum, meq/L	9.64	0.00
CalcTDS/Cond Ratio:			Anion Sum, meq/L	9.79	

*Elevated detection limit due to matrix interference.
AS+3/AS+5=BOTTLE 6
AS-ASIII =BOTTLE 10
AS-HCL =BOTTLE 11 AS-UNP.=BOTTLE 12
This report has been checked and is certified to be accurate.

Signed: Becke Johnson Date: 6/27/00
6/27/00 11:03

SVL ANALYTICAL, INC.
One Government Gulch ■ P.O. Box 929 ■ Kellogg, Idaho 83837-0929 ■ Phone: (208)784-1258 ■ Fax: (208)783-0891

REPORT OF ANALYTICAL RESULTS

Client: Shepherd Miller Inc.

Job No: 94485
Report Date: 7/11/00

Sample ID: NW-03-01-000524
Collected: 5/24/00 12:45 By: TR
Matrix: WATERG

SVL Sample: 233786 | 233788
Received: 5/25/00

PHYSICAL PROPERTIES	TOTAL	DISSOLVED
pH	8.96	
TDS, mg/L		585
TSS, mg/L	<0.1	
Conductivity		

NONMETALS (mg/L)	TOTAL	DISSOLVED
Alkalinity as CaCO3	220	
Bicarbonate	178	
Carbonate	41.2	
Hydroxide	<1.0	
Chloride	118	
Fluoride	0.6	
NO2+NO3-N	0.25	
Orthophosphate		
Sulfate	102	

METALS (mg/L)	TOTAL	DISSOLVED
Aluminum	<0.024	
Antimony	<0.001	
Arsenic	0.122	0.108
Barium	<0.002	
Beryllium	<0.002	
Bismuth		
Boron		
Cadmium	<0.0001	
Calcium	1.29	

METALS (cont'd)	TOTAL	DISSOLVED
Chromium	<0.005	<0.005
Cobalt		
Copper	<0.003	
Gallium		
Iron	<0.02	
Lanthanum		
Lead	<0.001	
Lithium		
Magnesium	0.510	
Manganese	<0.002	
Mercury	<0.0002	
Molybdenum		
Nickel	<0.023	
Phosphorus		
Potassium	7.3	
Scandium		
Selenium	<0.001	
Silica	24.3	
silver	<0.006	
Sodium	219	
Strontium		
Thallium	<0.001	
Tin		
Titanium		
Vanadium		
Zinc	<0.003	

ADDITIONAL TESTS	TOTAL	DISSOLVED		TOTAL	DISSOLVED
Color	<5.0		Turbidity	0.47	
Nitrite-N	<0.25*		Nitrate-N	0.49	
Phosphorus-Total	0.23		Arsenic - Unp.	0.123	
Arsenic - HCl		0.108	Arsenic - AsIII		<0.001
As+3 Speciation		<0.002	As+5 Speciation		0.100

QUALITY CONTROL

Calculated TDS:	611.8			
Meas/Calc TDS ratio:		Cation-Anion Balance	-0.41%	
TDS/Cond Ratio:		Cation Sum, meq/L	9.82	0.00
CalcTDS/Cond Ratio:		Anion Sum, meq/L	9.90	

*Elevated detection limit due to matrix interference.
AS+3/AS+5= BOTTLE 6
AS-ASIII = BOTTLE 10
AS-HCL = BOTTLE 11 AS-UNP.=BOTTLE 12

This report has been checked and is certified to be accurate.

Signed: Blake Johnson Date: 7/11/00

7/11/00 10:37

SVL ANALYTICAL, INC.

Quality Control Report

Part I Prep Blank and Laboratory Control Sample

Client :Shepherd Miller Inc.

SVL JOB No. :94485

Analyte	Method	Matrix	Units	Prep Blank	True—LCS—Found		LCS %R	Analysis Date
Silver	200.7	WATER	mg/L	<0.006	1.00	0.999	99.9	6/07/00
Aluminum	200.7	WATER	mg/L	<0.024	1.00	0.948	94.8	6/07/00
Barium	200.7	WATER	mg/L	<0.002	1.00	0.972	97.2	6/07/00
Beryllium	200.7	WATER	mg/L	<0.002	1.00	0.938	93.8	6/07/00
Calcium	200.7	WATER	mg/L	0.016	20.0	19.3	96.5	6/07/00
Chromium	200.7	WATER	mg/L	<0.005	1.00	0.946	94.6	6/07/00
Copper	200.7	WATER	mg/L	<0.003	1.00	0.957	95.7	6/07/00
Iron	200.7	WATER	mg/L	0.03	10.0	9.71	97.1	6/07/00
Potassium	200.7	WATER	mg/L	<1.7	30.0	28.9	96.3	6/07/00
Magnesium	200.7	WATER	mg/L	<0.035	20.0	19.2	96.0	6/07/00
Manganese	200.7	WATER	mg/L	<0.002	1.00	0.966	96.6	6/07/00
Sodium	200.7	WATER	mg/L	<0.088	20.0	19.4	97.0	6/07/00
Nickel	200.7	WATER	mg/L	<0.023	1.00	0.983	98.3	6/07/00
Silica	200.7	WATER	mg/L	<0.17	10.7	9.96	93.1	6/07/00
Zinc	200.7	WATER	mg/L	<0.003	1.00	0.939	93.9	6/07/00
Arsenic	206.2	WATER	mg/L	<0.001	0.050	0.051	102.0	6/02/00
Cadmium	213.2	WATER	mg/L	<0.0001	0.0500	0.0480	96.0	6/01/00
Lead	239.2	WATER	mg/L	<0.001	0.050	0.051	102.0	6/01/00
Antimony	204.2	WATER	mg/L	<0.001	0.050	0.043	86.0	5/31/00
Selenium	270.2	WATER	mg/L	<0.001	0.050	0.045	90.0	5/31/00
Thallium	279.2	WATER	mg/L	<0.001	0.050	0.052	104.0	6/01/00
Mercury	245.1	WATER	mg/L	<0.0002	0.0050	0.0052	104.0	6/02/00
Chloride	300.0	WATER	mg/L	<0.2	54.2	57.4	105.9	5/25/00
Fluoride	300.0	WATER	mg/L	<0.1	2.3	2.2	95.7	5/25/00
Nitrite-N	300.0	WATER	mg/L	<0.05	3.65	3.78	103.6	5/25/00
Nitrate-N	300.0	WATER	mg/L	<0.05	19.4	19.7	101.5	5/25/00
Sulfate, SO4	300.0	WATER	mg/L	<0.05	19.6	20.7	105.6	5/25/00
Alkalinity,CaCO3	310.1	WATER	mg/L	<1.0	73.0	70.4	96.4	5/31/00
CO3, CaCO3	310.1	WATER	mg/L		N/A		N/A	6/05/00
HCO3, CaCO3	310.1	WATER	mg/L		N/A		N/A	6/05/00
Hydroxide	310.1	WATER	mg/L		N/A		N/A	6/05/00
pH	150.1	WATER		5.22	9.23	9.04	97.9	5/31/00
Arsenic - HCl	206.2	WATER	mg/L	<0.001	0.050	0.051	102.0	5/30/00
Arsenic - AsIII	206.2	WATER	mg/L	<0.001	0.050	0.051	102.0	5/30/00
Arsenic - Unp.	206.2	WATER	mg/L	<0.001	0.050	0.051	102.0	5/30/00
Color	110.3	WATER		<5.0	N/A		N/A	5/25/00
TDS	160.1	WATER	mg/L	<1.0	337	294	87.2	5/31/00
TSS	160.2	WATER	mg/L	<0.1	42.7	41.6	97.4	5/31/00
As+3 Speciation	APDC	WATER	mg/L	0.002	0.050	0.055	110.0	5/26/00
As+5 Speciation	DIFF	WATER	mg/L		N/A		N/A	6/05/00
NO2+NO3-N	353.2	WATER	mg/L	<0.02	38.6	35.7	92.5	5/25/00
Phosphorus-Total	365.2	WATER	mg/L	<0.01	7.38	7.52	101.9	6/27/00
Turbidity	180.1	WATER	NTU's	0.06	1.79	1.84	102.8	5/26/00

LEGEND:

LCS = Laboratory Control Sample LCS %R = LCS Percent Recovery N/A = Not Applicable

6/27/00 11:09

SVL ANALYTICAL, INC. Quality Control Report

Part II Duplicate and Spike Analysis

Client :Shepherd Miller Inc. SVL JOB No :94485

Test	Method	Matrix	QC SAMPLE ID Units	Result	Duplicate Result	RPD%	Matrix Spike Result	SPK ADD	%R	Test Date
Ag	200.7	WATERG 1	mg/L	<0.006	<0.006	UDL	1.00	1.00	100.0	6/07/00
Al	200.7	WATERG 1	mg/L	<0.024	<0.024	UDL	0.956	1.00	95.6	6/07/00
Ba	200.7	WATERG 1	mg/L	<0.002	<0.002	UDL	0.997	1.00	99.7	6/07/00
Be	200.7	WATERG 1	mg/L	<0.002	<0.002	UDL	0.963	1.00	96.3	6/07/00
Ca	200.7	WATERG 1	mg/L	1.25	1.24	0.8	20.7	20.0	97.3	6/07/00
Cr	200.7	WATERG 1	mg/L	<0.005	<0.005	UDL	0.950	1.00	95.0	6/07/00
Cr	200.7	WATERG 2	mg/L	<0.005	<0.005	UDL	1.01	1.00	101.0	6/07/00
Cu	200.7	WATERG 1	mg/L	0.007	0.004	54.5	0.979	1.00	97.2	6/07/00
Fe	200.7	WATERG 1	mg/L	0.02	0.04	66.7	9.82	10.0	98.0	6/07/00
K	200.7	WATERG 1	mg/L	7.4	7.0	5.6	37.8	30.0	101.3	6/07/00
Mg	200.7	WATERG 1	mg/L	0.452	0.481	6.2	20.1	20.0	98.2	6/07/00
Mn	200.7	WATERG 1	mg/L	<0.002	<0.002	UDL	0.970	1.00	97.0	6/07/00
Na	200.7	WATERG 1	mg/L	215	213	0.9	241	20.0	R >4S	6/07/00
Ni	200.7	WATERG 1	mg/L	<0.023	<0.023	UDL	0.971	1.00	97.1	6/07/00
SiO2	200.7	WATERG 1	mg/L	24.0	24.0	0.0	34.7	10.7	100.0	6/07/00
Zn	200.7	WATERG 1	mg/L	0.009	0.007	25.0	0.957	1.00	94.8	6/07/00
As	206.2	WATERG 1	mg/L	0.119	0.118	0.8	0.193	0.0500	148.0	6/02/00
As	206.2	WATERG 2	mg/L	0.126	0.119	5.7	0.167	0.0500	82.0	6/02/00
Cd	213.2	WATERG 1	mg/L	<0.0001	<0.0001	UDL	0.0470	0.0500	94.0	6/01/00
Pb	239.2	WATERG 1	mg/L	<0.001	<0.001	UDL	0.054	0.0500	108.0	6/01/00
Sb	204.2	WATERG 1	mg/L	<0.001	<0.001	UDL	0.051	0.0500	102.0	5/31/00
Se	270.2	WATERG 1	mg/L	<0.001	<0.001	UDL	0.046	0.0500	92.0	5/31/00
Tl	279.2	WATERG 1	mg/L	<0.001	<0.001	UDL	0.045	0.0500	90.0	6/01/00
Hg	245.1	WATERG 1	mg/L	<0.0002	<0.0002	UDL	0.0011	0.0010	110.0	6/02/00
Cl	300.0	WATERG 1	mg/L	115	118	2.6	173	50.0	116.0	5/25/00
F	300.0	WATERG 1	mg/L	0.5	0.5	0.0	2.6	2.00	105.0	5/25/00
NO2-N	300.0	WATERG 1	mg/L	<0.25*	<0.25*	UDL	10.3	10.0	103.0	5/25/00
NO3-N	300.0	WATERG 1	mg/L	0.50	0.50	0.0	2.52	2.00	101.0	5/25/00
SO4	300.0	WATERG 1	mg/L	100	101	1.0	155	50.0	110.0	5/25/00
ALK	310.1	WATERG 1	mg/L	221	237	7.0	N/A	N/A	N/A	5/31/00
CO3	310.1	WATERG 1	mg/L	42.3	51.3	19.2	N/A	N/A	N/A	5/31/00
HCO3	310.1	WATERG 1	mg/L	178	185	3.9	N/A	N/A	N/A	5/31/00
OH	310.1	WATERG 1	mg/L	<1.0	<1.0	UDL	N/A	N/A	N/A	5/31/00
pH	150.1	WATERG 1		9.04	9.17	1.4	N/A	N/A	N/A	5/31/00
As HCl	206.2	WATERG 2	mg/L	0.114	0.113	0.9	0.174	0.0500	120.0	5/30/00
As III	206.2	WATERG 2	mg/L	<0.001	<0.001	UDL	0.050	0.0500	100.0	5/30/00
As Unp	206.2	WATERG 1	mg/L	0.090	0.123	31.0	0.120	0.0250	120.0	5/30/00
Color	110.3	WATERG 1		<5.0	<5.0	UDL	N/A	N/A	N/A	5/25/00
TDS	160.1	WATERG 2	mg/L	581	587	1.0	N/A	N/A	N/A	5/31/00
TSS	160.2	WATERG 1	mg/L	0.5	0.4	22.2	N/A	N/A	N/A	5/31/00
As+3	APDC	WATERG 2	mg/L	<0.002	<0.002	UDL	0.028	0.0250	112.0	5/26/00
As+5	DIFF	WATERG 2	mg/L	0.104	0.110	5.6	N/A	N/A	N/A	6/05/00
NO2NO3	353.2	WATERG 1	mg/L	0.30	0.30	0.0	1.47	1.00	117.0	5/25/00
P-TOT	365.2	WATERG 1	mg/L	0.24	0.22	8.7	0.73	0.500	98.0	6/27/00

LEGEND:

RPD% = (|SAM - DUP|/((SAM + DUP)/2) * 100) M in Duplicate indicates MSD. UDL = Both SAM & DUP not detected.

SPIKE ADD column, A = Post Digest Spike; %R = Percent Recovery N/A = Not Analyzed; R > 4S = Result more than 4X the Spike Added

QC Sample 1: SVL SAM No.: 233785 Client Sample ID: NW-01-01-000524 ^T

QC Sample 2: SVL SAM No.: 233787 Client Sample ID: NW-01-01-000524 ^D

SVL ANALYTICAL, INC. Quality Control Report

Part II Duplicate and Spike Analysis

Client :Shepherd Miller Inc. SVL JOB No :94485

Test	Method	Matrix	QC SAMPLE ID Units	Result	Duplicate Result	RPD%	Matrix Spike Result	SPK ADD	%R	Test Date
TURB	180.1	WATERG 1	NTU'S	0.42	0.43	2.4	N/A	N/A	N/A	5/26/00

LEGEND:

RPD% = (|SAM - DUP|/((SAM + DUP)/2) * 100) M in Duplicate indicates MSD. UDL = Both SAM & DUP not detected.

SPIKE ADD column, A = Post Digest Spike; %R = Percent Recovery N/A = Not Analyzed; R > 4S = Result more than 4X the Spike Added

QC Sample 1: SVL SAM No.: 233785 Client Sample ID: NW-01-01-000524 ^T

6/27/00 11:10

ACCULABS, INC.

Date: 07/13/00
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CASE NARRATIVE

Ms Chris Meyer
SVL Analytical
One Government Gulch
Kellogg, ID 83837

Lab Job Number: 038471 SVL002
Date Samples Received: 05/26/00
Customer PO Number: 2000353

The following samples were received at the laboratory:

00-A9278	Water
00-A9279	Water

The samples were received within EPA recommended holding times and in good condition. The radioactivity screen was performed at sample login, if required, and all results were within acceptable limits. If required, a pH screen confirmed that all samples were preserved to acceptable pH levels. Samples were analyzed within holding times as prescribed by the analytical method. Exceptions to these statements, additional information and any analytical anomalies are noted below.

The temperature of the samples upon arrival was 6 degrees C.

Sections A, B and C of this report contain a total of 4 pages.

Trudy L. Scott
Laboratory Manager

4663 TABLE MOUNTAIN DRIVE, GOLDEN, COLORADO 80403-1650
TELEPHONE (303)277-9514 FAX (303)277-9512 WWW.ACCULABS.COM

Date: 07/13/00
Page 1 - B

ACCULABS, INC.

REPORT OF ANALYSIS

Ms Chris Meyer
SVL Analytical
One Government Gulch
Kellogg, ID 83837

Lab Job Number: 038471 SVL002
Date Samples Received: 05/26/00
Customer PO Number: 2000353

Acculabs Designation:	00-A9278
Client Designation:	W233785
Sample Location: CLIENT ID:	NW-01-01-000524
Location II:	
Date/Time Collected	05/24/00 10:00

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	0.0019
Gross Alpha, total	7 +/- 5
Gross Beta, total	12 +/- 4
Radium-226, total	0.2 +/- 0.1
Radium-228, total	0.9 +/- 0.7
Radon-222, total	130 +/- 32

Acculabs Designation:	00-A9279
Client Designation:	W233786
Sample Location: CLIENT ID:	NW-03-01-000524
Location II:	
Date/Time Collected	05/24/00 12:45

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	0.0018
Gross Alpha, total	4 +/- 5
Gross Beta, total	17 +/- 5
Radium-226, total	0.2 +/- 0.2
Radium-228, total	0.6 +/- 0.6
Radon-222, total	110 +/- 30

ACCULABS, INC.

Date: 07/13/00
Page 2 - B

REPORT OF ANALYSIS

Ms Chris Meyer
SVL Analytical

Lab Job Number: 038471 SVL002
Date Samples Received: 05/26/00

NOTES:

Gross Alpha results are based on a Th-230 absorption curve.
Gross Beta results are based on a Cs-137 absorption curve.
Variability of the radioactive disintegration process (counting error) at the 95% confidence level is 1.96 sigma and the level of significance may exceed that of the reported analytical result.

Scheduled sample disposal/return date: August 12, 2000.

Eryda Hergensuler
for Trudy L. Scott
Laboratory Manager

Date: 07/13/00
Page 1 - C

ACCULABS, INC.

QA/QC Report for Acculabs Job Number 038471

PARAMETER	DETECTION LIMIT	DATE OF ANALYSIS	TIME OF ANALYSIS	ANALYST	METHOD
Lab Sample Number: 00-A9278					
Client Sample ID: W233785					
Gross Alpha, total	5 pCi/L	6/20/00	14:36	JD	References 1, 2, 3, 4, 6, 7,
Gross Beta, total	3 pCi/L	6/20/00	14:36	JD	References 1, 2, 3, 4, 6, 7,
Radium-226, total	0.5 pCi/L	6/27/00	14:17	JD	References 1, 2, 3, 4, 5, 8,
Radium-228, total	0.3 pCi/L	6/ 7/00	12:00	JS	References 1, 2, 3, 8
Radon-222, total	63 pCi/L	5/27/00	12:00	JS	References 4, 5
Uranium (KPA), total	0.0001 mg/L	6/17/00	9:38	JAL	Reference 16
Lab Sample Number: 00-A9279					
Client Sample ID: W233786					
Gross Alpha, total	5 pCi/L	6/20/00	14:36	JD	References 1, 2, 3, 4, 6, 7,
Gross Beta, total	3 pCi/L	6/20/00	14:36	JD	References 1, 2, 3, 4, 6, 7,
Radium-226, total	0.5 pCi/L	6/27/00	14:17	JD	References 1, 2, 3, 4, 5, 8,
Radium-228, total	0.3 pCi/L	6/ 7/00	12:00	JS	References 1, 2, 3, 8
Radon-222, total	60 pCi/L	5/27/00	12:00	JS	References 4, 5
Uranium (KPA), total	0.0001 mg/L	6/17/00	9:38	JAL	Reference 16

The reference summary for the Radiochemistry Methods is attached.

Approved by : EH Date : 7/13/00

ACCULABS, INC.

Date: 07/13/00
Page 1 - A

CASE NARRATIVE

Ms Chris Meyer
SVL Analytical
One Government Gulch
Kellogg, ID 83837

Lab Job Number: 038427 SVL002
Date Samples Received: 05/25/00
Customer PO Number: 2000349

The following samples were received at the laboratory:

00-A9158	Water

The samples were received within EPA recommended holding times and in good condition. The radioactivity screen was performed at sample login, if required, and all results were within acceptable limits. If required, a pH screen confirmed that all samples were preserved to acceptable pH levels. Samples were analyzed within holding times as prescribed by the analytical method. Exceptions to these statements, additional information and any analytical anomalies are noted below.

The temperature of the samples upon arrival was 3 degrees C.

Sections A, B and C of this report contain a total of 3 pages.

Eryda Hergenreder
for Trudy L. Scott
Laboratory Manager

4663 TABLE MOUNTAIN DRIVE, GOLDEN, COLORADO 80403-1650
TELEPHONE (303)277-9514 FAX (303)277-9512 WWW.ACCULABS.COM

Date: 07/13/00
Page 1 - B

ACCULABS, INC.

REPORT OF ANALYSIS

Ms Chris Meyer
SVL Analytical
One Government Gulch
Kellogg, ID 83837

Lab Job Number: 038427 SVL002
Date Samples Received: 05/25/00
Customer PO Number: 2000349

Acculabs Designation:	00-A9158
Client Designation:	W233647
Sample Location: CLIENT ID:	CW-02-01-000523
Location II:	
Date/Time Collected	05/23/00 9:30

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	0.0024
Gross Alpha, total	6 +/- 5
Gross Beta, total	12 +/- 4
Radium-226, total	0.3 +/- 0.2
Radium-228, total	1.4 +/- 0.6
Radon-222, total	64 +/- 21

NOTES:

Gross Alpha results are based on a Th-230 absorption curve.
Gross Beta results are based on a Cs-137 absorption curve.
Variability of the radioactive disintegration process (counting error) at the 95% confidence level is 1.96 sigma and the level of significance may exceed that of the reported analytical result.

Scheduled sample disposal/return date: August 12, 2000.

Lynda Hergenreder
for Trudy L. Scott
Laboratory Manager

Date: 07/13/00
Page 1 - C

ACCULABS, INC.

QA/QC Report for Acculabs Job Number 038427

PARAMETER	DETECTION LIMIT	DATE OF ANALYSIS	TIME OF ANALYSIS	ANALYST	METHOD
Lab Sample Number: 00-A9158					
Client Sample ID: W233647					
Gross Alpha, total	5 pCi/L	6/20/00	14:36	JD	References 1, 2, 3, 4, 6, 7, 8
Gross Beta, total	2 pCi/L	6/20/00	14:36	JD	References 1, 2, 3, 4, 6, 7, 8
Radium-226, total	0.5 pCi/L	6/27/00	14:17	JD	References 1, 2, 3, 4, 5, 8, 9
Radium-228, total	0.4 pCi/L	6/ 7/00	12:00	JS	References 1, 2, 3, 8
Radon-222, total	45 pCi/L	5/25/00	16:00	JD	References 4, 5
Uranium (KPA), total	0.0001 mg/L	6/17/00	9:38	JAL	Reference 16

The reference summary for the Radiochemistry Methods is attached.

Approved by : EoH Date : 7/13/00

ACCULABS, INC.

Date: 07/13/00
Page 1 - A

CASE NARRATIVE

Ms Chris Meyer
SVL Analytical
One Government Gulch
Kellogg, ID 83837

Lab Job Number: 038510 SVL002
Date Samples Received: 05/31/00
Customer PO Number: 2000361

The following samples were received at the laboratory:

00-A9381	Water
00-A9382	Water
00-A9383	Water

The samples were received within EPA recommended holding times and in good condition. The radioactivity screen was performed at sample login, if required, and all results were within acceptable limits. If required, a pH screen confirmed that all samples were preserved to acceptable pH levels. Samples were analyzed within holding times as prescribed by the analytical method. Exceptions to these statements, additional information and any analytical anomalies are noted below.

The temperature of the samples upon arrival was 14 degrees C.

Sections A, B and C of this report contain a total of 4 pages.

Trudy L. Scott
Laboratory Manager

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Telephone (303)277-9514 Fax (303)277-9512 WWW.ACCULABS.COM

Date: 07/13/00
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ACCULABS, INC.

REPORT OF ANALYSIS

Ms Chris Meyer
SVL Analytical
One Government Gulch
Kellogg, ID 83837

Lab Job Number: 038510 SVL002
Date Samples Received: 05/31/00
Customer PO Number: 2000361

Acculabs Designation:	00-A9381
Client Designation:	W233992
Sample Location: CLIENT ID:	CW-01-01-000525
Location II:	
Date/Time Collected	05/25/00 8:15

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	0.0021
Gross Alpha, total	-1 +/- 3
Gross Beta, total	7 +/- 3
Radium-226, total	0.2 +/- 0.2
Radium-228, total	1.2 +/- 0.7

Acculabs Designation:	00-A9382
Client Designation:	W233993
Sample Location: CLIENT ID:	CW-01-02-000525
Location II:	
Date/Time Collected	05/25/00 8:15

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	0.0021
Gross Alpha, total	9 +/- 5
Gross Beta, total	7 +/- 4
Radium-226, total	0.0 +/- 0.1
Radium-228, total	0.5 +/- 0.6

Acculabs Designation:	00-A9383
Client Designation:	W233994
Sample Location: CLIENT ID:	CW-03-01-000525
Location II:	
Date/Time Collected	05/25/00 13:30

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	0.0021
Gross Alpha, total	0 +/- 3
Gross Beta, total	7 +/- 4
Radium-226, total	-0.1 +/- 0.2
Radium-228, total	1.2 +/- 0.6

Date: 07/13/00
Page 2 - B

ACCULABS, INC.

REPORT OF ANALYSIS

Ms Chris Meyer
SVL Analytical

Lab Job Number: 038510 SVL002
Date Samples Received: 05/31/00

Acculabs Designation:	00-A9383
Client Designation:	W233994
Sample Location: CLIENT ID:	CW-03-01-000525
Location II:	
Date/Time Collected	05/25/00 13:30

NOTES:

Gross Alpha results are based on a Th-230 absorption curve.
Gross Beta results are based on a Cs-137 absorption curve.
Variability of the radioactive disintegration process (counting error) at the 95% confidence level is 1.96 sigma and the level of significance may exceed that of the reported analytical result.

Scheduled sample disposal/return date: August 12, 2000.

Eyda Hergenreder
for Trudy L. Scott
Laboratory Manager

Date: 07/13/00
Page 1 - C

ACCULABS, INC.

QA/QC Report for Acculabs Job Number 038510

PARAMETER	DETECTION LIMIT	DATE OF ANALYSIS	TIME OF ANALYSIS	ANALYST	METHOD
Lab Sample Number: 00-A9381					
Client Sample ID: W233992					
Gross Alpha, total	5 pCi/L	6/20/00	14:36	JD	References 1, 2, 3, 4, 6, 7, 8
Gross Beta, total	2 pCi/L	6/20/00	14:36	JD	References 1, 2, 3, 4, 6, 7, 8
Radium-226, total	0.5 pCi/L	6/27/00	14:17	JD	References 1, 2, 3, 4, 5, 8, 9
Radium-228, total	0.3 pCi/L	6/ 7/00	12:00	JS	References 1, 2, 3, 8
Uranium (KPA), total	0.0001 mg/L	6/17/00	9:38	JAL	Reference 16
Lab Sample Number: 00-A9382					
Client Sample ID: W233993					
Gross Alpha, total	5 pCi/L	6/20/00	14:36	JD	References 1, 2, 3, 4, 6, 7, 8
Gross Beta, total	3 pCi/L	6/20/00	14:36	JD	References 1, 2, 3, 4, 6, 7, 8
Radium-226, total	0.5 pCi/L	6/27/00	14:17	JD	References 1, 2, 3, 4, 5, 8, 9
Radium-228, total	0.3 pCi/L	6/ 7/00	12:00	JS	References 1, 2, 3, 8
Uranium (KPA), total	0.0001 mg/L	6/17/00	9:38	JAL	Reference 16
Lab Sample Number: 00-A9383					
Client Sample ID: W233994					
Gross Alpha, total	5 pCi/L	6/20/00	14:36	JD	References 1, 2, 3, 4, 6, 7, 8
Gross Beta, total	3 pCi/L	6/20/00	14:36	JD	References 1, 2, 3, 4, 6, 7, 8
Radium-226, total	0.5 pCi/L	6/27/00	14:17	JD	References 1, 2, 3, 4, 5, 8, 9
Radium-228, total	0.3 pCi/L	6/ 7/00	12:00	JS	References 1, 2, 3, 8
Uranium (KPA), total	0.0001 mg/L	6/17/00	9:38	JAL	Reference 16

The reference summary for the Radiochemistry Methods is attached.

Approved by : EB Date : 7/13/00

Date: 05/31/00
Page 1 - B

ACCULABS, INC.

REPORT OF ANALYSIS

Ms Chris Meyer
SVL Analytical
One Government Gulch
Kellogg, ID 83837

Lab Job Number: 038467 SVL002
Date Samples Received: 05/26/00

Acculabs Designation:	00-A9269
Client Designation:	CW-01-01-000525
Sample Location:	
Location II:	
Date/Time Collected	05/25/00 8:15

Radiochemistry (results in pCi/L unless noted):

Radon-222, total	90 +/- 24

Acculabs Designation:	00-A9270
Client Designation:	CW-01-02-000525
Sample Location:	
Location II:	
Date/Time Collected	05/25/00 8:15

Radiochemistry (results in pCi/L unless noted):

Radon-222, total	89 +/- 24

Acculabs Designation:	00-A9271
Client Designation:	CW-03-01-000525
Sample Location:	
Location II:	
Date/Time Collected	05/25/00 13:30

Radiochemistry (results in pCi/L unless noted):

Radon-222, total	120 +/- 28

Acculabs Designation:	00-A9272
Client Designation:	CW-04-01-000525
Sample Location:	
Location II:	
Date/Time Collected	05/25/00 15:00

Radiochemistry (results in pCi/L unless noted):

Radon-222, total	120 +/- 28

Date: 05/31/00
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ACCULABS, INC.

REPORT OF ANALYSIS

Ms Chris Meyer
SVL Analytical

Lab Job Number: 038467 SVL002
Date Samples Received: 05/26/00

Acculabs Designation:	00-A9272
Client Designation:	CW-04-01-000525
Sample Location:	
Location II:	
Date/Time Collected	05/25/00 15:00

NOTES:

Variability of the radioactive disintegration process (counting error) at the 95% confidence level is 1.96 sigma and the level of significance may exceed that of the reported analytical result.

Scheduled sample disposal/return date: June 30, 2000.

Trudy L. Scott

Trudy L. Scott
Laboratory Manager

Date: 05/31/00
Page 1 - C

ACCULABS, INC.

QA/QC Report for Acculabs Job Number 038467

PARAMETER	DETECTION LIMIT	DATE OF ANALYSIS	TIME OF ANALYSIS	ANALYST	METHOD
Lab Sample Number: 00-A9269 Client Sample ID: CW-01-01-000525 Radon-222, total	48 pCi/L	5/27/00	12:00	JS	References 4, 5
Lab Sample Number: 00-A9270 Client Sample ID: CW-01-02-000525 Radon-222, total	48 pCi/L	5/27/00	12:00	JS	References 4, 5
Lab Sample Number: 00-A9271 Client Sample ID: CW-03-01-000525 Radon-222, total	55 pCi/L	5/27/00	12:00	JS	References 4, 5
Lab Sample Number: 00-A9272 Client Sample ID: CW-04-01-000525 Radon-222, total	55 pCi/L	5/27/00	12:00	JS	References 4, 5

The reference summary for the Radiochemistry Methods is attached.

Approved by : TH Date : 5.31.00

Date: 07/19/00
Page 1 - B

ACCULABS, INC.

REPORT OF ANALYSIS

Ms Chris Meyer
SVL Analytical
One Government Gulch
Kellogg, ID 83837

Lab Job Number: 038512 SVL002
Date Samples Received: 05/31/00
Customer PO Number: 2000363

Acculabs Designation:	00-A9386	
Client Designation:	W234064	CW-04-01-000526
Sample Location:		
Location II:		
Date/Time Collected	05/26/00 8:45	

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	0.0022
Gross Alpha, total	4 +/- 4
Gross Beta, total	7 +/- 4
Radium-226, total	0.1 +/- 0.1
Radium-228, total	1.3 +/- 0.6

Acculabs Designation:	00-A9387	
Client Designation:	W234065	CW-04-03-000526
Sample Location:		
Location II:		
Date/Time Collected	05/26/00 10:30	

Radiochemistry (results in pCi/L unless noted):

Uranium, total (mg/L)	< 0.0001
Gross Alpha, total	1 +/- 0
Gross Beta, total	1 +/- 1
Radium-226, total	0.1 +/- 0.1
Radium-228, total	0.7 +/- 0.5

NOTES:

Gross Alpha results are based on a Th-230 absorption curve.
Gross Beta results are based on a Cs-137 absorption curve.
Variability of the radioactive disintegration process (counting error) at the 95% confidence level is 1.96 sigma and the level of significance may exceed that of the reported analytical result.

Scheduled sample disposal/return date: August 18, 2000.

Trudy L. Scott
Laboratory Manager

Date: 07/19/00
Page 1 - A

ACCULABS, INC.

CASE NARRATIVE

Ms Chris Meyer
SVL Analytical
One Government Gulch
Kellogg, ID 83837

Lab Job Number: 038512 SVL002
Date Samples Received: 05/31/00
Customer PO Number: 2000363

The following samples were received at the laboratory:

00-A9386	Water
00-A9387	Water

The samples were received within EPA recommended holding times and in good condition. The radioactivity screen was performed at sample login, if required, and all results were within acceptable limits. If required, a pH screen confirmed that all samples were preserved to acceptable pH levels. Samples were analyzed within holding times as prescribed by the analytical method. Exceptions to these statements, additional information and any analytical anomalies are noted below.

The temperature of the samples upon arrival was 14 degrees C.

Sections A, B and C of this report contain a total of 3 pages.

Trudy L. Scott
Laboratory Manager

4663 Table Mountain Drive, Golden, Colorado 80403-1650
Telephone (303)277-9514 Fax (303)277-9512 WWW.ACCULABS.COM

Date: 07/19/00
Page 1 - C

ACCULABS, INC.

QA/QC Report for Acculabs Job Number 038512

PARAMETER	DETECTION LIMIT	DATE OF ANALYSIS	TIME OF ANALYSIS	ANALYST	METHOD
Lab Sample Number: 00-A9386					
Client Sample ID: W234064					
Gross Alpha, total	5 pCi/L	7/18/00	14:19	JAL	References 1, 2, 3, 4, 6, 7, 8
Gross Beta, total	3 pCi/L	7/18/00	14:19	JAL	References 1, 2, 3, 4, 6, 7, 8
Radium-226, total	0.1 pCi/L	7/ 3/00	6:00	JD	References 1, 2, 3, 4, 5, 8, 9
Radium-228, total	0.4 pCi/L	6/ 7/00	12:00	JS	References 1, 2, 3, 8
Uranium (KPA), total	0.0001 mg/L	6/17/00	9:38	JAL	Reference 16
Lab Sample Number: 00-A9387					
Client Sample ID: W234065					
Gross Alpha, total	0 pCi/L	7/18/00	14:19	JAL	References 1, 2, 3, 4, 6, 7, 8
Gross Beta, total	0 pCi/L	7/18/00	14:19	JAL	References 1, 2, 3, 4, 6, 7, 8
Radium-226, total	0.1 pCi/L	7/ 3/00	6:00	JD	References 1, 2, 3, 4, 5, 8, 9
Radium-228, total	0.3 pCi/L	6/ 7/00	12:00	JS	References 1, 2, 3, 8
Uranium (KPA), total	0.0001 mg/L	6/17/00	9:38	JAL	Reference 16

The reference summary for the Radiochemistry Methods is attached.

Approved by : EH Date : 7/19/00

Acculabs Inc. Report of F8514 Rev. A

Blank Analysis

Units: pCi /Blank

SVL JOB#: 94467

Acculabs # 38427	Gross Alpha	Gross Beta	Ra-226	Ra-228	kpa				
Blank 1	0.110 +/- 0.772	0.243 +/- 0.200	-0.012 +/- 0.089	1.067 +/- 0.696	-0.0357 +/- 0.00133	+/-	+/-	+/-	+/-
Blank 2	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Blank 3	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Blank 4	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Blank 5	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Blank 6	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Blank 7	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Blank 8	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-

Acculabs Inc. F8513 Rev. A

Report of
Replicate Analysis

Matrix: water

Units: pCi/L ** kpa in uG/L

SVL JOB#: 94467

RER = Relative Error Ratio
Acceptance Criteria RER <=1

Acculabs # 38427	Gross Alpha	Gross Beta	Ra-226	Ra-228	Rn-222	kpa			
9278	7.120 +/- 4.84	11.9 +/- 3.9	+/-	+/-	+/-	+/-	+/-	+/-	+/-
9278R	-0.010 +/- 2.68	8.17 +/- 3.97	+/-	+/-	+/-	+/-	+/-	+/-	+/-
RER	0.948	0.474							
9158	+/-	+/-	+/-	+/-	64.106 +/- 21.02	+/-	+/-	+/-	+/-
9158R	+/-	+/-	+/-	+/-	42.601 +/- 18.43	+/-	+/-	+/-	+/-
R					0.545				
9273	+/-	+/-	0.124 +/- 0.094	+/-	+/-	+/-	+/-	+/-	+/-
9273R	+/-	+/-	0.011 +/- 0.084	+/-	+/-	+/-	+/-	+/-	+/-
RER			0.635						
9703	+/-	+/-	+/-	0.73 +/- 0.514	+/-	+/-	+/-	+/-	+/-
9703R	+/-	+/-	+/-	0.615 +/- 0.538	+/-	+/-	+/-	+/-	+/-
RER				0.109					
9535	+/-	+/-	+/-	+/-	+/-	1.2187 +/- 0.0368	+/-	+/-	+/-
9535R	+/-	+/-	+/-	+/-	+/-	1.1987 +/- 0.0364	+/-	+/-	+/-
R						0.273			

Acculabs Inc. F8511 Rev. A

Report of

Matrix: water Decision Level Concentration

Units: pCi/L *** kpa in uG/L

SVL JOB#: 94467
CLIENT ID: CW-02-01-000523

Acculabs # 38427	Gross Alpha	Gross Beta	Ra-226	Ra-228	Rn-222	kpa						
9158	4.76	2.46	0.468	0.37	44.62	0.073						

Acculabs Inc. F8512 Rev A

Report of

Matrix: water Laboratory Control Sample

Units: pCi/ml ** kpa in uG/L SVL JOB#: 94467

Acculabs # 38427	Gross Alpha	Gross Beta	Ra-226	Ra-228	kpa			
Actual Value	439 +/-	640 +/-	2978 +/-	2848.8 +/-	30.06 +/-	+/-	+/-	+/-
Calculated Value	354 +/- 70	681 +/- 65	2642 +/- 786	2591 +/- 405	31.7 +/- 0.0546	+/-	+/-	+/-
% Recovery	80.6%	106.4%	88.7%	91.0%	105.5%			
Acculabs #								
Actual Value	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Calculated Value	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
% Recovery								
Calculated Value	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
% Recovery								
Calculated Value	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
% Recovery								

Acculabs Inc. F8513 Rev. A

Report of
Replicate Analysis

Matrix: water

Units: pCi/L ** kpa in uG/L

SVL JOB#: 94485
RER = Relative Error Ratio
Acceptance Criteria RER <=1

Acculabs # 38471	Gross Alpha	Gross Beta	Ra-226	Ra-228	Rn-222	kpa			
9278	7.120 +/- 4.84	11.9 +/- 3.9	+/-	+/-	129.414 +/- 16.217	+/-	+/-	+/-	+/-
9278R	-0.010 +/- 2.68	8.17 +/- 3.97	+/-	+/-	114.702 +/- 15.232	+/-	+/-	+/-	+/-
RER	0.948	0.474			0.468				
9279	+/-	+/-	+/-	+/-	114.445 +/- 15.109	+/-	+/-	+/-	+/-
9279R	+/-	+/-	+/-	+/-	103.266 +/- 14.384	+/-	+/-	+/-	+/-
R					0.379				
9273	+/-	+/-	0.124 +/- 0.094	+/-	+/-	+/-	+/-	+/-	+/-
9273R	+/-	+/-	0.011 +/- 0.084	+/-	+/-	+/-	+/-	+/-	+/-
RER			0.635						
9703	+/-	+/-	+/-	0.73 +/- 0.514	+/-	+/-	+/-	+/-	+/-
9703R	+/-	+/-	+/-	0.615 +/- 0.538	+/-	+/-	+/-	+/-	+/-
RER				0.109					
9535	+/-	+/-	+/-	+/-	+/-	1.2187 +/- 0.0368	+/-	+/-	+/-
9535R	+/-	+/-	+/-	+/-	+/-	1.1987 +/- 0.0364	+/-	+/-	+/-
R						0.273			

Acculabs Inc. F8511 Rev. A

Report of

Matrix: water Decision Level Concentration

Units: pCi/L *** kpa in uG/L SVL JOB#: 94485

Acculabs # 38471	Gross Alpha	Gross Beta	Ra-226	Ra-228	Rn-222	kpa						
9278	5.24	2.74	0.451	0.31	63.58	0.073						
9279	5.43	2.89	0.502	0.33	59.95	0.073						

	CLIENT ID
9278	NW-01-01-000524
9279	NW-03-01-000524

Acculabs Inc. F8512 Rev A

Report of

Matrix: water Laboratory Control Sample

Units: pCi/ml ** kpa in uG/L SVL JOB#: 94485

Acculabs # 38471	Gross Alpha	Gross Beta	Ra-226	Ra-228	kpa			
Actual Value	439 +/-	640 +/-	2978 +/-	2848.8 +/-	30.06 +/-	+/-	+/-	+/-
Calculated Value	354 +/- 70	681 +/- 65	2642 +/- 786	2591 +/- 405	31.7 +/- 0.0546	+/-	+/-	+/-
% Recovery	80.6%	106.4%	88.7%	91.0%	105.5%			
Acculabs #								
Actual Value	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Calculated Value	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
% Recovery								
Calculated Value	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
% Recovery								
Calculated Value	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
% Recovery								

Acculabs Inc. Report of F8514 Rev. A

Blank Analysis

Units: pCi /Blank

SVL JOB#: 94485

Acculabs # 38471	Gross Alpha	Gross Beta	Ra-226	Ra-228	kpa				
Blank 1	0.110 +/- 0.772	0.243 +/- 0.200	-0.012 +/- 0.089	1.067 +/- 0.696	-0.0357 +/- 0.00133	+/-	+/-	+/-	+/-
Blank 2	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Blank 3	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Blank 4	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Blank 5	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Blank 6	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Blank 7	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Blank 8	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-

Acculabs Inc. F8512 Rev A

Report of

Matrix: water Laboratory Control Sample

Units: pCi/ml ** kpa in uG/L SVL JOB#: 94504

Acculabs # 38510	Gross Alpha	Gross Beta	Ra-226	Ra-228	kpa			
Actual Value	439 +/-	640 +/-	2978 +/-	2848.8 +/-	30.06 +/-	+/-	+/-	+/-
Calculated Value	354 +/- 70	681 +/- 65	2642 +/- 786	2591 +/- 405	31.7 +/- 0.0546	+/-	+/-	+/-
% Recovery	80.6%	106.4%	88.7%	91.0%	105.5%			
Acculabs #								
Actual Value	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Calculated Value	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
% Recovery								
Calculated Value	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
% Recovery								
Calculated Value	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
% Recovery								

Acculabs Inc. Report of F8514 Rev. A

Blank Analysis

Units: pCi /Blank

SVL JOB#: 94504

Acculabs # 38510	Gross Alpha	Gross Beta	Ra-226	Ra-228	kpa				
Blank 1	0.110 +/- 0.772	0.243 +/- 0.200	-0.012 +/- 0.089	1.067 +/- 0.696	-0.0357 +/- 0.00133	+/-	+/-	+/-	+/-
Blank 2	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Blank 3	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Blank 4	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Blank 5	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Blank 6	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Blank 7	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Blank 8	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-

Acculabs Inc. F8513 Rev. A

Report of
Replicate Analysis

Matrix: water

SVL JOB#: 94504

Units: pCi/L ** kpa in uG/L

RER = Relative Error Ratio
Acceptance Criteria RER <=1

Acculabs # 38510	Gross Alpha	Gross Beta	Ra-226	Ra-228	kpa				
9278	7.120 +/- 4.84	11.9 +/- 3.9	+/-	+/-	+/-	+/-	+/-	+/-	+/-
9278R	-0.010 +/- 2.68	8.17 +/- 3.97	+/-	+/-	+/-	+/-	+/-	+/-	+/-
RER	0.948	0.474							
9273	+/-	+/-	0.124 +/- 0.094	+/-	+/-	+/-	+/-	+/-	+/-
9273R	+/-	+/-	0.011 +/- 0.084	+/-	+/-	+/-	+/-	+/-	+/-
RER			0.635						
9703	+/-	+/-	+/-	0.73 +/- 0.514	+/-	+/-	+/-	+/-	+/-
9703R	+/-	+/-	+/-	0.615 +/- 0.538	+/-	+/-	+/-	+/-	+/-
RER				0.109					
9535	+/-	+/-	+/-	+/-	1.2187 +/- 0.0368	+/-	+/-	+/-	+/-
9535R	+/-	+/-	+/-	+/-	1.1987 +/- 0.0364	+/-	+/-	+/-	+/-
RER					0.273				

·labs Inc. F8511 Rev. A

Report of

Matrix: water Decision Level Concentration

Units: pCi/L *** kpa in uG/L SVL JOB#: 94504

Acculabs # 38510	Gross Alpha	Gross Beta	Ra-226	Ra-228	kpa							
9381	4.76	2.49	0.505	0.33	0.0730							
9382	5.08	2.52	0.451	0.30	0.0753							
9383	5.02	2.55	0.519	0.33	0.0753							

	CLIENT ID
9381	CW-01-01-000525
9382	CW-01-02-000525
9383	CW-03-01-000525

Acculabs Inc. F8512 Rev A

Report of

Matrix: water Laboratory Control Sample

Units: pCi/ml ** kpa in uG/L SVL JOB#: 94508

Acculabs # 38512	Gross Alpha	Gross Beta	Ra-226	Ra-228	kpa			
Actual Value	36 +/-	38 +/-	2978 +/-	2848.8 +/-	30.06 +/-	+/-	+/-	+/-
Calculated Value	34 +/- 3	38 +/- 6	2929 +/- 860	2591 +/- 405	31.7 +/- 0.0546	+/-	+/-	+/-
% Recovery	94.4%	100.0%	98.4%	91.0%	105.5%			
Acculabs #								
Actual Value	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Calculated Value	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
% Recovery								
Calculated Value	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
% Recovery								
Calculated Value	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
% Recovery								

ulabs Inc. Report of F8514 Rev. A

Blank Analysis

Units: pCi /Blank

SVL JOB#: 94508

Acculabs # 38512	Gross Alpha	Gross Beta	Ra-226	Ra-228	kpa				
Blank 1	0.280 +/- 0.17	0.18 +/- 0.370	0.000 +/- 0.091	1.067 +/- 0.696	-0.0357 +/- 0.00133	+/-	+/-	+/-	+/-
Blank 2	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Blank 3	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
ank 4	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Blank 5	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Blank 6	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Blank 7	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Blank 8	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-

ulabs Inc. F8513 Rev. A

Report of
Replicate Analysis

Matrix: water

SVL JOB#: 94508

Units: pCi/L ** kpa in uG/L

RER = Relative Error Ratio
Acceptance Criteria RER <=1

Acculabs # 38512	Gross Alpha	Gross Beta	Ra-226	Ra-228	kpa				
9702	8.900 +/- 6.11	12.23 +/- 3.64	+/-	+/-	+/-	+/-	+/-	+/-	+/-
9702R	15.910 +/- 6.51	14.08 +/- 4.2	+/-	+/-	+/-	+/-	+/-	+/-	+/-
RER	0.555	0.236							
9386	+/-	+/-	0.08 +/- 0.092	+/-	+/-	+/-	+/-	+/-	+/-
9386R	+/-	+/-	0.033 +/- 0.126	+/-	+/-	+/-	+/-	+/-	+/-
RER			0.216						
9703	+/-	+/-	+/-	0.73 +/- 0.514	+/-	+/-	+/-	+/-	+/-
9703R	+/-	+/-	+/-	0.615 +/- 0.538	+/-	+/-	+/-	+/-	+/-
RER				0.109					
9535	+/-	+/-	+/-	+/-	1.2187 +/- 0.0368	+/-	+/-	+/-	+/-
9535R	+/-	+/-	+/-	+/-	1.1987 +/- 0.0364	+/-	+/-	+/-	+/-
RER					0.273				

Acculabs Inc. F8511 Rev. A

Report of

Matrix: water Decision Level Concentration

Units: pCi/L *** kpa in uG/L SVL JOB#: 94508

Acculabs # 38512	Gross Alpha	Gross Beta	Ra-226	Ra-228	kpa							
9386	4.51	2.63	0.146	0.36	0.0902							
9387	0.2600	0.5	0.106	0.29	0.0902							

	CLIENT ID
9386	CW-04-01-000526
9387	CW-04-03-000526

AAL ENVIRONMENTAL LLC

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1500 Glendale Ave.
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Final

REPORT OF ANALYSIS

Client:	**City of Fallon c/o Shepherd-Miller Inc.** Tim Runnells
Project:	
AAL Ref:	EV5466
Report Date:	08-10-00
Samples received by:	K.McCrea
Date Received:	05-23-00
Time Received:	3:51 p.m.
Conditions:	Sample was delived to lab in good condition by T. Runnells. Temperature upon reception was 19.3C.
Samples Received:	1 water sample for analysis as requested Data package to include spike results
	Sample Labeled:
	CW-02-01-000523

NOTE: See attached sheet for QA/QC for all analysis performed using EPA300.0.

This report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report is for the exclusive use of the client to whom it is addressd and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

CLIENT: City of Fallon c/o Shepherd-Miller Inc.
AAL REF: EV5466
ATTN: Tim Runnells

ANALYSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER			DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
CW-02-01-000523	ALKALINITY, TOTAL	mg/L	1		115	1	APHA2320B	05/30/00
CW-02-01-000523	ALKALINITY, BICARBONATE	mg/L	1		73	1	APHA2320B	05/30/00
CW-02-01-000523	ALKALINITY, CARBONATE	mg/L	1		42	1	APHA2320B	05/30/00
CW-02-01-000523	ALKALINITY, HYDROXIDE	mg/L	1		ND	1	APHA2320B	05/30/00
CW-02-01-000523	ALUMINUM	mg/L	4	<	0.020	0.020	200.7	05/24/00
CW-02-01-000523	ANTIMONY	mg/L	4	<	0.003	0.003	200.8	06/15/00
CW-02-01-000523	ARSENIC	mg/L	4		0.105	0.005	200.8	06/13/00
CW-02-01-000523	ARSENIC	mg/L	12		0.139	0.005	200.8	06/13/00
CW-02-01-000523	ARSENIC	mg/L	5		0.132	0.005	200.8	06/13/00
CW-02-01-000523	ARSENIC	mg/L	11		0.108	0.005	200.7	06/13/00
CW-02-01-000523	ARSENIC (III)	mg/L	10	<	0.005	0.005	200.7	05/24/00
CW-02-01-000523	BARIUM	mg/L	4	<	0.020	0.020	200.7	05/24/00
CW-02-01-000523	BERYLLIUM	mg/L	4	<	0.002	0.002	200.7	05/24/00
CW-02-01-000523	CADMIUM	mg/L	4	<	0.002	0.002	200.8	06/13/00
CW-02-01-000523	CALCIUM	mg/L	1		1.72	0.50	200.7	06/06/00
CW-02-01-000523	CHLORIDE	mg/L	1		86.4	0.2	300.0	05/26/00
CW-02-01-000523	CHROMIUM	mg/L	4	<	0.005	0.005	200.7	05/24/00
CW-02-01-000523	CHROMIUM	mg/L	5	<	0.005	0.005	200.7	06/16/00
CW-02-01-000523	COLOR - APPARENT	c.u.	1		0-5	5	APHA2120B	06/01/00
CW-02-01-000523	COPPER	mg/L	4	<	0.010	0.010	200.7	05/24/00
CW-02-01-000523	FLUORIDE	mg/L	1		0.6	0.1	300.0	05/24/00
CW-02-01-000523	IRON	mg/L	4	<	0.020	0.020	200.7	05/24/00
CW-02-01-000523	LEAD	mg/L	4	<	0.007	0.007	200.8	06/15/00
CW-02-01-000523	MAGNESIUM	mg/L	1		0.59	0.10	200.7	06/06/00
CW-02-01-000523	MANGANESE	mg/L	4	<	0.005	0.005	200.7	05/24/00
CW-02-01-000523	MERCURY	mg/L	4	<	0.0005	0.0005	245.1	06/05/00
CW-02-01-000523	NICKEL	mg/L	4	<	0.020	0.020	200.8	06/15/00
CW-02-01-000523	NITRATE / NITRITE as N	mg/L	3	<	2.0	2.0	300.0	06/18/00
CW-02-01-000523	NITRATE as N	mg/L	1		0.4	0.1	300.0	05/24/00
CW-02-01-000523	NITRITE as N	mg/L	1	<	0.1	0.1	300.0	05/24/00
CW-02-01-000523	pH	s.u.	1		9.34	0.01	APHA4500H+B	05/23/00
CW-02-01-000523	POTASSIUM	mg/L	1		10.7	0.10	200.7	06/06/00
CW-02-01-000523	SELENIUM	mg/L	4		0.017	0.010	200.8	06/13/00
CW-02-01-000523	SILICA	mg/L	1		33.0	0.025	200.7	06/06/00
CW-02-01-000523	SILVER	mg/L	4	<	0.010	0.010	200.8	06/13/00
CW-02-01-000523	SODIUM	mg/L	1		220	0.50	200.7	06/06/00
CW-02-01-000523	SULFATE	mg/L	1		82.1	0.4	300.0	05/24/00
CW-02-01-000523	TDS	mg/L	1		544	10	APHA2540C	05/26/00
CW-02-01-000523	THALLIUM	mg/L	4		0.002	0.001	200.8	06/13/00
CW-02-01-000523	TSS	mg/L	1	<	2	2	APHA2540D	05/26/00
CW-02-01-000523	TURBIDITY	NTU	1		0.4	0.1	APHA2130B	05/24/00
CW-02-01-000523	ZINC	mg/L	4	<	0.050	0.050	200.7	05/24/00
CW-02-01-000523	GROSS ALPHA*	pCi/L	7		7 +/- 5	6	1, 2, 3, 4, 6, 7, 8	05/31/00
CW-02-01-000523	GROSS BETA*	pCi/L	7		13 +/- 4	3	1, 2, 3, 4, 6, 7, 8	05/31/00
CW-02-01-000523	RADIUM 228*	pCi/L	8,9		0.1 +/- 0.1	0.5	1, 2, 3, 4, 5, 8, 9	06/27/00
CW-02-01-000523	RADIUM 228*	pCi/L	8,9		0.9 +/- 0.6	0.3	1, 2, 3, 8	06/07/00
CW-02-01-000523	URANIUM*	pCi/L	8,9		0.0008	0.0001	16	06/01/00
CW-02-01-000523	RADON*	mg/L			45 +/- 18	38	4, 5	05-24-00

*See attached list of method references

CATIONS	9.98
ANIONS	6.92
%DIFFERENCE	9.06

Karl W. McCrea
Laboratory Director

is report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAL ENVIRONMENTAL LLC

CLIENT: City of Fallon c/o Shepherd-Miller, Inc.
AAL REF: EV5466
ATTN: Tim Runnells

ANALYSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER			DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
CW-02-01-000523	SELENIUM	mg/L	4		0.019	0.010	200.8	08/08/00
CW-02-01-000523	THALLIUM	mg/L	4	<	0.001	0.001	200.8	08/08/00

Re-analyzed per client request

Karl W. McCrea
Laboratory Director

his report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAL ENVIRONMENT LLC

CLIENT: City of Fallon c/o Shepherd-Miller Inc.
AAL REF: EV5466
ATTN: Tim Runnells
ANALYSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER		Result	Spike Value	Spike Conc.	Percent Recovery	METHOD DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
CW-02-01-000523	ALKALINITY, TOTAL	mg/L	1		115	160	47.8	92.4	1	APHA2320B	05/30/00
CW-02-01-000523	ALKALINITY, BICARBONATE	mg/L	1		N/A	N/A	N/A	N/A	1	APHA2320B	05/30/00
CW-02-01-000523	ALKALINITY, CARBONATE	mg/L	1		N/A	N/A	N/A	N/A	1	APHA2320B	05/30/00
CW-02-01-000523	ALKALINITY, HYDROXIDE	mg/L	1		N/A	N/A	N/A	N/A	1	APHA2320B	05/30/00
CW-02-01-000523	ALUMINUM	mg/L	4	<	0.020	2.51	2.50	100.0	0.020	200.7	05/24/00
CW-02-01-000523	ANTIMONY	mg/L	4	<	0.003	0.100	0.100	100.0	0.003	200.8	06/15/00
CW-02-01-000523	ARSENIC	mg/L	4		0.105	2.66	2.50	102.2	0.005	200.8	06/13/00
CW-02-01-000523	ARSENIC	mg/L	12		0.139	2.83	2.50	107.6	0.005	200.8	06/13/00
CW-02-01-000523	ARSENIC	mg/L	5		0.132	2.80	2.50	106.7	0.005	200.8	06/13/00
CW-02-01-000523	ARSENIC	mg/L	11		0.108	2.82	2.50	108.0	0.005	200.7	06/13/00
CW-02-01-000523	ARSENIC (III)	mg/L	10	<	0.005	2.74	2.50	110.0	0.005	200.7	05/24/00
CW-02-01-000523	BARIUM	mg/L	4	<	0.020	5.02	5.00	100.0	0.020	200.7	05/24/00
CW-02-01-000523	BERYLLIUM	mg/L	4	<	0.002	0.106	0.100	106.0	0.002	200.8	05/24/00
CW-02-01-000523	CADMIUM	mg/L	4	<	0.002	0.094	0.100	94.0	0.002	200.8	06/13/00
CW-02-01-000523	CALCIUM	mg/L	1		1.72	54.8	50.0	106.0	0.50	200.7	06/06/00
CW-02-01-000523	CHLORIDE*	mg/L	1		2.16	5.29	3.00	104.4	0.2	300.0	06/18/00
CW-02-01-000523	CHROMIUM	mg/L	4	<	0.005	0.101	0.100	101.0	0.005	200.8	05/24/00
CW-02-01-000523	CHROMIUM	mg/L	5	<	0.005	0.0985	0.100	99.0	0.005	200.8	06/15/00
CW-02-01-000523	COLOR - APPARENT	c.u.	1		N/A	N/A	N/A	N/A	5	APHA2120B	06/01/00
CW-02-01-000523	COPPER	mg/L	4	<	0.010	0.992	0.100	99.0	0.010	200.8	05/24/00
CW-02-01-000523	FLUORIDE*	mg/L	1		0.294	2.31	2.00	100.9	0.1	300.0	06/18/00
CW-02-01-000523	IRON	mg/L	4	<	0.020	2.52	2.5	101.0	0.020	200.7	05/24/00
CW-02-01-000523	LEAD	mg/L	4	<	0.007	0.124	0.100	124.0	0.007	200.8	06/15/00
CW-02-01-000523	MAGNESIUM	mg/L	1		0.591	53.6	50.0	106.0	0.10	200.7	06/06/00
CW-02-01-000523	MANGANESE	mg/L	4	<	0.005	2.53	2.50	101.0	0.005	200.7	05/24/00
[illegible]-01-000523	MERCURY	mg/L	4	<	0.0005	0.00270	0.0025	108	0.0005	245.1	06/05/00
[illegible]2-01-000523	NICKEL	mg/L	4	<	0.020	0.957	1.00	95.7	0.020	200.7	06/13/00
CW-02-01-000523	NITRATE / NITRITE as N*	mg/L	3	<	2.0	6.572	5.500	103.2	2.0	300.0	06/16/00
CW-02-01-000523	NITRATE as N*	mg/L	1		0.19	2.61	2.50	97.0	0.1	300.0	06/18/00
CW-02-01-000523	NITRITE as N*	mg/L	1	<	0.10	3.16	3.00	105.3	0.1	300.0	06/18/00
CW-02-01-000523	pH	s.u.	1		N/A	N/A	N/A	N/A	0.01	APHA4500H+B	05/23/00
CW-02-01-000523	POTASSIUM	mg/L	1		10.7	73.3	50.0	125.0	0.10	200.7	06/06/00
CW-02-01-000523	SELENIUM	mg/L	4		0.017	2.67	2.50	106.1	0.010	200.7	06/13/00
CW-02-01-000523	SILICA	mg/L	1		15.7	20.3	5.0	92.0	0.025	200.7	06/13/00
CW-02-01-000523	SILVER	mg/L	4	<	0.010	0.048	0.050	96.0	0.010	200.8	06/13/00
CW-02-01-000523	SODIUM	mg/L	1		220	271	50.0	102.0	0.50	200.7	06/06/00
CW-02-01-000523	SULFATE*	mg/L	1		42.5	58.7	15.0	107.8	0.4	300.0	06/18/00
CW-02-01-000523	TDS	mg/L	1		544	646	781	95.9	10	APHA2540C	05/26/00
CW-02-01-000523	THALLIUM	mg/L	4		0.0015	0.102	0.100	100.0	0.001	200.8	06/13/00
CW-02-01-000523	TSS	mg/L	1		N/A	N/A	N/A	N/A	2	APHA2540D	05/26/00
CW-02-01-000523	TURBIDITY	NTU	1		N/A	N/A	N/A	N/A	0.1	APHA2130B	05/24/00
CW-02-01-000523	ZINC	mg/L	4	<	0.050	1.04	1.00	104.0	0.050	200.7	05/24/00
CW-02-01-000523	GROSS ALPHA	pCi/L	7		N/A	N/A	N/A	N/A	6	1, 2, 3, 4, 6, 7, 8	—
CW-02-01-000523	GROSS BETA	pCi/L	7		N/A	N/A	N/A	N/A	3	1, 2, 3, 4, 6, 7, 8	—
CW-02-01-000523	RADIUM 226	pCi/L	8,9		N/A	N/A	N/A	N/A	0.5	1, 2, 3, 4, 5, 8, 9	—
CW-02-01-000523	RADIUM 228	pCi/L	8,9		N/A	N/A	N/A	N/A	0.3	1, 2, 3, 8	—
CW-02-01-000523	URANIUM	pCi/L	8,9		N/A	N/A	N/A	N/A	0.0001	16	—
CW-02-01-000523	RADON	mg/L			N/A	N/A	N/A	N/A	38	4, 5	—

* EPA300.0 Anions - 'Result' represents portion contributed by sample for LFM analysis.

Karl W. McCrea
L[illegible]tory Director

[illegible]s report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report [illegible] for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAL ENVIRONMENTAL LLC

AAL ENVIRONMENTAL LLC

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Final

REPORT OF ANALYSIS

Client:	**City of Fallon c/o Shepherd-Miller Inc.** Tim Runnells
Project:	
AAL Ref:	EV5469
Report Date:	08-10-00
Samples received by:	K.McCrea
Date Received:	05-24-00
Time Received:	4:20 p.m.
Conditions:	Samples were delived to lab in good condition by T. Runnells. Temperature upon reception was 19.6C.
Samples Received:	2 water samples for analysis as requested

Samples Labeled:

NW-01-01-000524
NW-03-01-000524

This report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report is for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

CLIENT: City of Fallon/c/o Sharlek/Butler Inc
AAL REF: EV5469
ATTN: Tim Runnells
ANALYSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER			DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
NW-01-01-000524	ALKALINITY, TOTAL	mg/L	1		246	1	APHA2320B	05/31/00
NW-01-01-000524	ALKALINITY, BICARBONATE	mg/L	1		184	1	APHA2320B	05/31/00
NW-01-01-000524	ALKALINITY, CARBONATE	mg/L	1		62	1	APHA2320B	05/31/00
NW-01-01-000524	ALKALINITY, HYDROXIDE	mg/L	1		ND	1	APHA2320B	05/31/00
NW-01-01-000524	ALUMINUM	mg/L	4	<	0.020	0.020	200.7	06/06/00
NW-01-01-000524	ANTIMONY	mg/L	4		0.019	0.003	200.8	06/13/00
NW-01-01-000524	ARSENIC	mg/L	4		0.146	0.005	200.8	06/13/00
NW-01-01-000524	ARSENIC	mg/L	12		0.124	0.005	200.8	06/13/00
NW-01-01-000524	ARSENIC	mg/L	5		0.117	0.005	200.8	06/13/00
NW-01-01-000524	ARSENIC	mg/L	11		0.117	0.005	200.7	05/25/00
NW-01-01-000524	ARSENIC (III)	mg/L	10	<	0.005	0.005	200.7	05/25/00
NW-01-01-000524	BARIUM	mg/L	4	<	0.020	0.020	200.7	06/06/00
NW-01-01-000524	BERYLLIUM	mg/L	4	<	0.002	0.002	200.7	06/06/00
NW-01-01-000524	CADMIUM	mg/L	4	<	0.002	0.002	200.8	06/13/00
NW-01-01-000524	CALCIUM	mg/L	1		1.10	0.50	200.7	05/26/00
NW-01-01-000524	CHLORIDE	mg/L	1		102	0.2	300.0	05/26/00
NW-01-01-000524	CHROMIUM	mg/L	4	<	0.005	0.005	200.7	06/06/00
NW-01-01-000524	CHROMIUM	mg/L	5	<	0.005	0.005	200.7	06/15/00
NW-01-01-000524	COLOR - APPARENT	c.u.	1		0-5	5	APHA2120B	05/26/00
NW-01-01-000524	COPPER	mg/L	4	<	0.010	0.010	200.7	06/06/00
NW-01-01-000524	FLUORIDE	mg/L	1		0.8	0.1	300.0	05/25/00
NW-01-01-000524	IRON	mg/L	4	<	0.020	0.020	200.7	06/06/00
NW-01-01-000524	LEAD	mg/L	4	<	0.007	0.007	200.8	06/15/00
NW-01-01-000524	MAGNESIUM	mg/L	1		0.56	0.10	200.7	05/26/00
NW-01-01-000524	MANGANESE	mg/L	4	<	0.005	0.005	200.7	06/06/00
NW-01-01-000524	MERCURY	mg/L	4	<	0.0005	0.0005	245.1	06/05/00
NW-01-01-000524	NICKEL	mg/L	4	<	0.020	0.020	200.8	06/13/00
NW-01-01-000524	NITRATE / NITRITE as N	mg/L	3	<	2.0	2.0	300.0	6/13/00
NW-01-01-000524	NITRATE as N	mg/L	1		0.5	0.1	300.0	05/25/00
NW-01-01-000524	NITRITE as N	mg/L	1	<	0.1	0.1	300.0	05/25/00
NW-01-01-000524	pH	s.u.	1		9.45	0.01	APHA4500H+B	05/24/00
NW-01-01-000524	POTASSIUM	mg/L	1		12.6	0.10	200.7	05/26/00
NW-01-01-000524	SELENIUM	mg/L	4		0.076	0.010	200.8	06/13/00
NW-01-01-000524	SILICA	mg/L	1		30.0	0.025	200.7	05/26/00
NW-01-01-000524	SILVER	mg/L	4	<	0.010	0.010	200.8	06/13/00
NW-01-01-000524	SODIUM	mg/L	1		270	0.50	200.7	05/26/00
NW-01-01-000524	SULFATE	mg/L	1		91.4	0.4	300.0	05/26/00
NW-01-01-000524	TDS	mg/L	1		512	10	APHA2540C	05/26/00
NW-01-01-000524	THALLIUM	mg/L	4		0.002	0.001	200.8	06/13/00
NW-01-01-000524	TSS	mg/L	1	<	2	2	APHA2540D	05/26/00
NW-01-01-000524	TURBIDITY	NTU	1		0.1	0.1	APHA2130B	05/25/00
NW-01-01-000524	ZINC	mg/L	4	<	0.050	0.050	200.7	06/06/00
NW-01-01-000524	GROSS ALPHA	pCi/L	7		5 +/- 4	5	1,2,3,4,6,7,8*	07/18/00
NW-01-01-000524	GROSS BETA	pCi/L	7		7 +/- 4	3	1,2,3,4,6,7,8*	07/18/00
NW-01-01-000524	RADIUM 226	pCi/L	8,9		0.0 +/- 0.1	0.4	1,2,3,4,5,8,9*	07/06/00
NW-01-01-000524	RADIUM 228	pCi/L	8,9		0.8 +/- .6	0.3	1,2,3,8*	06/07/00
NW-01-01-000524	URANIUM	pCi/L	8,9		0.0018	0.0001	16*	06/17/00
NW-01-01-000524	RADON	pCi/L			150 +/- 33	64	4, 5*	05-27-00

*See attached list of method references

CATIONS	12.2
ANIONS	9.94
%DIFFERENCE	5.0

Karl W. McCrea
Laboratory Director

This report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report is for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAL ENVIRONMENTAL LLC

CLIENT: City of Fallon c/o Stephenson Miller Inc.
AAL REF: EV5469
ATTN: Tim Runnels
ANALYSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER			DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
NW-03-01-000524	ALKALINITY, TOTAL	mg/L	1		247	1	APHA2320B	05/31/00
NW-03-01-000524	ALKALINITY, BICARBONATE	mg/L	1		183	1	APHA2320B	05/31/00
NW-03-01-000524	ALKALINITY, CARBONATE	mg/L	1		64	1	APHA2320B	05/31/00
NW-03-01-000524	ALKALINITY, HYDROXIDE	mg/L	1		ND	1	APHA2320B	05/31/00
NW-03-01-000524	ALUMINUM	mg/L	4	<	0.020	0.020	200.7	06/06/00
NW-03-01-000524	ANTIMONY	mg/L	4		0.006	0.003	200.8	06/13/00
NW-03-01-000524	ARSENIC	mg/L	4		0.118	0.005	200.8	06/13/00
NW-03-01-000524	ARSENIC	mg/L	12		0.125	0.005	200.8	06/13/00
NW-03-01-000524	ARSENIC	mg/L	5		0.118	0.005	200.8	06/13/00
NW-03-01-000524	ARSENIC	mg/L	11		0.118	0.005	200.7	05/25/00
NW-03-01-000524	ARSENIC (III)	mg/L	10	<	0.005	0.005	200.7	05/25/00
NW-03-01-000524	BARIUM	mg/L	4	<	0.020	0.020	200.7	06/06/00
NW-03-01-000524	BERYLLIUM	mg/L	4	<	0.002	0.002	200.7	06/06/00
NW-03-01-000524	CADMIUM	mg/L	4	<	0.002	0.002	200.8	06/13/00
NW-03-01-000524	CALCIUM	mg/L	1		0.92	0.50	200.7	05/26/00
NW-03-01-000524	CHLORIDE	mg/L	1		103	0.2	300.0	05/26/00
NW-03-01-000524	CHROMIUM	mg/L	4	<	0.005	0.005	200.7	06/06/00
NW-03-01-000524	CHROMIUM	mg/L	5	<	0.005	0.005	200.7	06/15/00
NW-03-01-000524	COLOR - APPARENT	c.u.	1		5-10	5	APHA2120B	05/26/00
NW-03-01-000524	COPPER	mg/L	4	<	0.010	0.010	200.7	06/06/00
NW-03-01-000524	FLUORIDE	mg/L	1		0.7	0.1	300.0	05/25/00
NW-03-01-000524	IRON	mg/L	4	<	0.020	0.020	200.7	06/06/00
NW-03-01-000524	LEAD	mg/L	4	<	0.007	0.007	200.8	06/13/00
NW-03-01-000524	MAGNESIUM	mg/L	1		0.55	0.10	200.7	05/26/00
NW-03-01-000524	MANGANESE	mg/L	4	<	0.005	0.005	200.7	06/06/00
NW-03-01-000524	MERCURY	mg/L	4	<	0.0005	0.0005	245.1	06/05/00
NW-03-01-000524	NICKEL	mg/L	4	<	0.020	0.020	200.8	06/13/00
NW-03-01-000524	NITRATE / NITRITE as N	mg/L	3	<	2.0	2.0	300.0	06/18/00
NW-03-01-000524	NITRATE as N	mg/L	1		0.5	0.1	300.0	05/25/00
NW-03-01-000524	NITRITE as N	mg/L	1	<	0.1	0.1	300.0	05/25/00
NW-03-01-000524	pH	s.u.	1		9.43	0.01	APHA4500H+B	05/24/00
NW-03-01-000524	POTASSIUM	mg/L	1		11.8	0.10	200.7	06/14/00
NW-03-01-000524	SELENIUM	mg/L	4		0.043	0.010	200.8	06/13/00
NW-03-01-000524	SILICA	mg/L	1		33.6	0.025	200.7	05/26/00
NW-03-01-000524	SILVER	mg/L	4	<	0.010	0.010	200.8	06/13/00
NW-03-01-000524	SODIUM	mg/L	1		268	0.50	200.7	05/26/00
NW-03-01-000524	SULFATE	mg/L	1		92.8	0.4	300.0	05/26/00
NW-03-01-000524	TDS	mg/L	1		608	10	APHA2540C	05/26/00
NW-03-01-000524	THALLIUM	mg/L	4	<	0.001	0.001	200.8	06/13/00
NW-03-01-000524	TSS	mg/L	1	<	2	2	APHA2540D	05/26/00
NW-03-01-000524	TURBIDITY	NTU	1		0.1	0.1	APHA2130B	05/25/00
NW-03-01-000524	ZINC	mg/L	4	<	0.050	0.050	200.7	06/06/00
NW-03-01-000524	GROSS ALPHA	pCi/L	7		5 +/- 4	5	1,2,3,4,6,7,8*	07/18/00
NW-03-01-000524	GROSS BETA	pCi/L	7		9 +/- 4	3	1,2,3,4,6,7,8*	07/18/00
NW-03-01-000524	RADIUM 226	pCi/L	8,9		0.0 +/- 0.1	0.3	1,2,3,4,5,8,9*	07/06/00
NW-03-01-000524	RADIUM 228	pCi/L	8,9		0.5 +/- 0.5	0.3	1,2,3,8*	06/07/00
NW-03-01-000524	URANIUM	pCi/L	8,9		0.0020	0.0001	16*	06/17/00
NW-03-01-000524	RADON	pCi/L			110 +/- 27	54	4, 5*	05-27-00

*See attached list of method references

CATIONS	12.05
ANIONS	10.15
%DIFFERENCE	4.3

Karl W. McCrea
Laboratory Director

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AAL ENVIRONMENTAL LLC

CLIENT: City of Fallon c/o Shepherd-Miller Inc.
AAL REF: EV5469
ATTN: Tim Runnells
ANALYSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER			DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
NW-01-01-000524	SELENIUM	mg/L	4	<	0.010	0.010	200.8	08/08/00
NW-01-01-000524	THALLIUM	mg/L	4	<	0.001	0.001	200.8	08/08/00

Re-analyzed per client request.

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER			DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
NW-03-01-000524	SELENIUM	mg/L	4	<	0.010	0.010	200.8	08/08/00
NW-03-01-000524	THALLIUM	mg/L	4	<	0.001	0.001	200.8	08/08/00

Re-analyzed per client request.

Karl W. McCrea
Laboratory Director

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AAL ENVIRONMENTAL LLC

AAL
ENVIRONMENTAL
LLC

Sparks Office
1500 Glendale Ave.
Nevada 89431
Box 11530
Reno NV 89510
(775) 356-0606
Fax
(775) 356-1413

Final

REPORT OF ANALYSIS

Client:	**City of Fallon c/o Shepherd-Miller Inc.** Tim Runnells
Project:	
AAL Ref:	EV5480
Report Date:	08-11-00
Samples received by:	K.McCrea
Date Received:	05-25-00
Time Received:	5:25 p.m.
Conditions:	Samples were delived to lab in good condition by T. Runnells. Temperature upon reception was 18.6
Samples Received:	3 water samples for analysis as requested Data package to include replicate 1 water sample for Radon analysis

Samples Labeled:

CW-01-01-000525
CW-01-02-000525
CW-03-01-000525
CW-04-01-000525

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CLIENT: City of Fallon c/o Shepherd-Miller Inc.
AAL REF: EV5480
ATTN: Tim Runnells
ANALYSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER			DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
CW-01-01-000525	ALKALINITY, TOTAL	mg/L	1		223	1	APHA2320B	05/31/00
CW-01-01-000525	ALKALINITY, BICARBONATE	mg/L	1		170	1	APHA2320B	05/31/00
CW-01-01-000525	ALKALINITY, CARBONATE	mg/L	1		53	1	APHA2320B	05/31/00
CW-01-01-000525	ALKALINITY, HYDROXIDE	mg/L	1		ND	1	APHA2320B	05/31/00
CW-01-01-000525	ALUMINUM	mg/L	4		0.024	0.020	200.7	06/06/00
CW-01-01-000525	ANTIMONY	mg/L	4	<	0.003	0.003	200.8	06/15/00
CW-01-01-000525	ARSENIC	mg/L	4		0.114	0.005	200.8	06/13/00
CW-01-01-000525	ARSENIC	mg/L	12		0.114	0.005	200.8	06/13/00
CW-01-01-000525	ARSENIC	mg/L	5		0.113	0.005	200.8	06/13/00
CW-01-01-000525	ARSENIC	mg/L	11		0.109	0.005	200.7	06/06/00
CW-01-01-000525	ARSENIC (III)	mg/L	10	<	0.005	0.005	200.7	06/06/00
CW-01-01-000525	BARIUM	mg/L	4	<	0.020	0.020	200.7	06/06/00
CW-01-01-000525	BERYLLIUM	mg/L	4	<	0.002	0.002	200.7	06/06/00
CW-01-01-000525	CADMIUM	mg/L	4	<	0.002	0.002	200.8	06/13/00
CW-01-01-000525	CALCIUM	mg/L	1		1.37	0.50	200.7	06/06/00
CW-01-01-000525	CHLORIDE	mg/L	1		98.1	0.2	300.0	06/18/00
CW-01-01-000525	CHROMIUM	mg/L	4	<	0.005	0.005	200.7	06/06/00
CW-01-01-000525	CHROMIUM	mg/L	5	<	0.005	0.005	200.7	06/06/00
CW-01-01-000525	COLOR - APPARENT	c.u.	1		5-10	5	APHA2120B	05/26/00
CW-01-01-000525	COPPER	mg/L	4	<	0.010	0.010	200.7	06/06/00
CW-01-01-000525	FLUORIDE	mg/L	1		0.6	0.1	300.0	05/26/00
CW-01-01-000525	IRON	mg/L	4	<	0.020	0.020	200.7	06/14/00
CW-01-01-000525	LEAD	mg/L	4	<	0.007	0.007	200.8	06/13/00
CW-01-01-000525	MAGNESIUM	mg/L	1		0.57	0.10	200.7	06/06/00
CW-01-01-000525	MANGANESE	mg/L	4	<	0.005	0.005	200.7	06/06/00
CW-01-01-000525	MERCURY	mg/L	4	<	0.0005	0.0005	245.1	06/05/00
CW-01-01-000525	NICKEL	mg/L	4	<	0.020	0.020	200.8	06/13/00
CW-01-01-000525	NITRATE / NITRITE as N	mg/L	3	<	2.0	2.0	300.0	06/18/00
CW-01-01-000525	NITRATE as N	mg/L	1		0.4	0.1	300.0	05/26/00
CW-01-01-000525	NITRITE as N	mg/L	1	<	0.1	0.1	300.0	05/26/00
CW-01-01-000525	pH	s.u.	1		9.50	0.01	APHA4500H+B	05/26/00
CW-01-01-000525	POTASSIUM	mg/L	1		10.7	0.10	200.7	06/06/00
CW-01-01-000525	SELENIUM	mg/L	4		0.023	0.010	200.8	06/15/00
CW-01-01-000525	SILICA	mg/L	1		34.2	0.025	200.7	06/06/00
CW-01-01-000525	SILVER	mg/L	4	<	0.010	0.010	200.8	06/13/00
CW-01-01-000525	SODIUM	mg/L	1		220	0.50	200.7	06/06/00
CW-01-01-000525	SULFATE	mg/L	1		83.6	0.4	300.0	05/26/00
CW-01-01-000525	TDS	mg/L	1		514	10	APHA2540C	05/30/00
CW-01-01-000525	THALLIUM	mg/L	4	<	0.001	0.001	200.8	06/13/00
CW-01-01-000525	TSS	mg/L	1	<	2	2	APHA2540D	05/26/00
CW-01-01-000525	TURBIDITY	NTU	1		0.5	0.1	APHA2130B	05/26/00
CW-01-01-000525	ZINC	mg/L	4	<	0.050	0.050	200.7	06/06/00
CW-01-01-000525	GROSS ALPHA*	pCi/L	7		6 +/- 5	5	1, 2, 3, 4, 6, 7, 8	07/18/00
CW-01-01-000525	GROSS BETA*	pCi/L	7		13 +/- 4	2	1, 2, 3, 4, 6, 7, 8	07/18/00
CW-01-01-000525	RADIUM 226*	pCi/L	8,9		0.0 +/- 0.1	0.1	1, 2, 3, 4, 5, 8, 9	06/20/00
CW-01-01-000525	RADIUM 228*	pCi/L	8,9		0.0 +/- 0.5	0.3	1, 2, 3, 8	06/13/00
CW-01-01-000525	URANIUM*	mg/L	8,9		0.0021	0.0001	16	06/17/00
CW-01-01-000525	RADON*	pCi/L			99 +/- 24	49	4, 5	05-27-00

*See attached list of method references

CATIONS	9.96
ANIONS	9.24
%DIFFERENCE	1.89

Karl W. McCrea
Laboratory Director

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AAL ENVIRONMENTAL LLC

CLIENT: City of Fallon c/o Shepherd Miller Inc.
AAL REF: EV5480
ATTN: Tim Runnells

ANALYSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER			DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
CW-01-02-000525	ALKALINITY, TOTAL	mg/L	1		225	1	APHA2320B	05/31/00
CW-01-02-000525	ALKALINITY, BICARBONATE	mg/L	1		173	1	APHA2320B	05/31/00
CW-01-02-000525	ALKALINITY, CARBONATE	mg/L	1		52	1	APHA2320B	05/31/00
CW-01-02-000525	ALKALINITY, HYDROXIDE	mg/L	1		ND	1	APHA2320B	05/31/00
CW-01-02-000525	ALUMINUM	mg/L	4		0.024	0.020	200.7	06/06/00
CW-01-02-000525	ANTIMONY	mg/L	4	<	0.003	0.003	200.8	06/13/00
CW-01-02-000525	ARSENIC	mg/L	4		0.108	0.005	200.8	06/13/00
CW-01-02-000525	ARSENIC	mg/L	12		0.110	0.005	200.8	06/13/00
CW-01-02-000525	ARSENIC	mg/L	5		0.111	0.005	200.8	06/13/00
CW-01-02-000525	ARSENIC	mg/L	11		0.106	0.005	200.7	06/06/00
CW-01-02-000525	ARSENIC (III)	mg/L	10	<	0.005	0.005	200.7	06/06/00
CW-01-02-000525	BARIUM	mg/L	4	<	0.020	0.020	200.7	06/06/00
CW-01-02-000525	BERYLLIUM	mg/L	4	<	0.002	0.002	200.7	06/06/00
CW-01-02-000525	CADMIUM	mg/L	4	<	0.002	0.002	200.8	06/13/00
CW-01-02-000525	CALCIUM	mg/L	1		1.47	0.50	200.7	06/06/00
CW-01-02-000525	CHLORIDE	mg/L	1		87.2	0.2	300.0	05/26/00
CW-01-02-000525	CHROMIUM	mg/L	4	<	0.005	0.005	200.7	06/06/00
CW-01-02-000525	CHROMIUM	mg/L	5	<	0.005	0.005	200.7	06/06/00
CW-01-02-000525	COLOR - APPARENT	c.u.	1		10-15	5	APHA2120B	05/26/00
CW-01-02-000525	COPPER	mg/L	4	<	0.010	0.010	200.7	06/06/00
CW-01-02-000525	FLUORIDE	mg/L	1		0.6	0.1	300.0	05/26/00
CW-01-02-000525	IRON	mg/L	4	<	0.020	0.020	200.7	06/06/00
CW-01-02-000525	LEAD	mg/L	4	<	0.007	0.007	200.8	06/13/00
CW-01-02-000525	MAGNESIUM	mg/L	1		0.64	0.10	200.7	06/06/00
CW-01-02-000525	MANGANESE	mg/L	4	<	0.005	0.005	200.7	06/06/00
CW-01-02-000525	MERCURY	mg/L	4	<	0.0005	0.0005	245.1	06/05/00
CW-01-02-000525	NICKEL	mg/L	4	<	0.020	0.020	200.8	06/13/00
CW-01-02-000525	NITRATE / NITRITE as N	mg/L	3	<	2.0	2.0	300.0	06/13/00
CW-01-02-000525	NITRATE as N	mg/L	1		0.4	0.1	300.0	05/26/00
CW-01-02-000525	NITRITE as N	mg/L	1	<	0.1	0.1	300.0	05/26/00
CW-01-02-000525	pH	s.u.	1		9.52	0.01	APHA4500H+B	05/26/00
CW-01-02-000525	POTASSIUM	mg/L	1		11.3	0.10	200.7	06/06/00
CW-01-02-000525	SELENIUM	mg/L	4		0.046	0.010	200.8	06/13/00
CW-01-02-000525	SILICA	mg/L	1		16.9	0.025	200.7	06/06/00
CW-01-02-000525	SILVER	mg/L	4	<	0.010	0.010	200.8	06/13/00
CW-01-02-000525	SODIUM	mg/L	1		225	0.50	200.7	06/06/00
CW-01-02-000525	SULFATE	mg/L	1		83.3	0.4	300.0	05/26/00
CW-01-02-000525	TDS	mg/L	1		532	10	APHA2540C	05/30/00
CW-01-02-000525	THALLIUM	mg/L	4	<	0.001	0.001	200.8	06/13/00
CW-01-02-000525	TSS	mg/L	1	<	2	2	APHA2540D	05/26/00
CW-01-02-000525	TURBIDITY	NTU	1		0.3	0.1	APHA2130B	05/26/00
CW-01-02-000525	ZINC	mg/L	4	<	0.050	0.050	200.7	06/06/00
CW-01-02-000525	GROSS ALPHA*	pCi/L	7		7 +/- 6	6	1, 2, 3, 4, 6, 7, 8	07/18/00
CW-01-02-000525	GROSS BETA*	pCi/L	7		16 +/- 4	3	1, 2, 3, 4, 6, 7, 8	07/18/00
CW-01-02-000525	RADIUM 226*	pCi/L	8,9		0.9 +/- 0.3	0.2	1, 2, 3, 4, 5, 8, 9	07/03/00
CW-01-02-000525	RADIUM 228*	pCi/L	8,9		0.8 +/- 1.1	0.6	1, 2, 3, 8	06/13/00
CW-01-02-000525	URANIUM*	mg/L	8,9		0.0020	0.0001	16	06/17/00
CW-01-02-000525	RADON*	pCi/L			100 +/- 25	49	4, 5	05-27-00

*See attached list of method references

CATIONS	10.20
ANIONS	8.94
%DIFFERENCE	3.30

Karl W. McCrea
Laboratory Director

This report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAL ENVIRONMENTAL LLC

CLIENT: City of Fallon c/o Stephens-Miller Inc.
AAL REF: EV5460
ATTN: Tim Runnells
ANALYSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER			DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
CW-03-01-000525	ALKALINITY, TOTAL	mg/L	1		223	1	APHA2320B	05/31/00
CW-03-01-000525	ALKALINITY, BICARBONATE	mg/L	1		169	1	APHA2320B	05/31/00
CW-03-01-000525	ALKALINITY, CARBONATE	mg/L	1		54	1	APHA2320B	05/31/00
CW-03-01-000525	ALKALINITY, HYDROXIDE	mg/L	1		ND	1	APHA2320B	05/31/00
CW-03-01-000525	ALUMINUM	mg/L	4	<	0.020	0.020	200.7	06/06/00
CW-03-01-000525	ANTIMONY	mg/L	4	<	0.003	0.003	200.8	06/13/00
CW-03-01-000525	ARSENIC	mg/L	4		0.108	0.005	200.8	06/13/00
CW-03-01-000525	ARSENIC	mg/L	12		0.097	0.005	200.8	06/13/00
CW-03-01-000525	ARSENIC	mg/L	5		0.096	0.005	200.8	06/13/00
CW-03-01-000525	ARSENIC	mg/L	11		0.104	0.005	200.7	06/06/00
CW-03-01-000525	ARSENIC (III)	mg/L	10	<	0.005	0.005	200.7	06/06/00
CW-03-01-000525	BARIUM	mg/L	4	<	0.020	0.020	200.7	06/06/00
CW-03-01-000525	BERYLLIUM	mg/L	4	<	0.002	0.002	200.7	06/06/00
CW-03-01-000525	CADMIUM	mg/L	4	<	0.002	0.002	200.8	06/13/00
CW-03-01-000525	CALCIUM	mg/L	1		1.38	0.50	200.7	06/06/00
CW-03-01-000525	CHLORIDE	mg/L	1		85.1	0.2	300.0	05/27/00
CW-03-01-000525	CHROMIUM	mg/L	4	<	0.005	0.005	200.7	06/06/00
CW-03-01-000525	CHROMIUM	mg/L	5	<	0.005	0.005	200.7	06/06/00
CW-03-01-000525	COLOR - APPARENT	c.u.	1		10-15	5	APHA2120B	05/26/00
CW-03-01-000525	COPPER	mg/L	4	<	0.010	0.010	200.7	06/06/00
CW-03-01-000525	FLUORIDE	mg/L	1		0.5	0.1	300.0	05/27/00
CW-03-01-000525	IRON	mg/L	4	<	0.020	0.020	200.7	06/06/00
CW-03-01-000525	LEAD	mg/L	4	<	0.007	0.007	200.8	06/13/00
CW-03-01-000525	MAGNESIUM	mg/L	1		0.58	0.10	200.7	06/06/00
CW-03-01-000525	MANGANESE	mg/L	4	<	0.005	0.005	200.7	06/06/00
CW-03-01-000525	MERCURY	mg/L	4	<	0.0005	0.0005	245.1	06/05/00
CW-03-01-000525	NICKEL	mg/L	4	<	0.020	0.020	200.8	06/13/00
CW-03-01-000525	NITRATE / NITRITE as N	mg/L	3	<	2.0	2.0	300.0	06/18/00
CW-03-01-000525	NITRATE as N	mg/L	1		0.3	0.1	300.0	05/27/00
CW-03-01-000525	NITRITE as N	mg/L	1	<	0.1	0.1	300.0	05/27/00
CW-03-01-000525	pH	s.u.	1		9.51	0.01	APHA4500H+B	05/26/00
CW-03-01-000525	POTASSIUM	mg/L	1		11.0	0.10	200.7	06/06/00
CW-03-01-000525	SELENIUM	mg/L	4		0.040	0.010	200.8	06/13/00
CW-03-01-000525	SILICA	mg/L	1		34.4	0.025	200.7	06/06/00
CW-03-01-000525	SILVER	mg/L	4	<	0.010	0.010	200.8	06/13/00
CW-03-01-000525	SODIUM	mg/L	1		226	0.50	200.7	06/06/00
CW-03-01-000525	SULFATE	mg/L	1		81.6	0.4	300.0	05/27/00
CW-03-01-000525	TDS	mg/L	1		508	10	APHA2540C	05/30/00
CW-03-01-000525	THALLIUM	mg/L	4	<	0.001	0.001	200.8	06/13/00
CW-03-01-000525	TSS	mg/L	1	<	2	2	APHA2540D	05/26/00
CW-03-01-000525	TURBIDITY	NTU	1		0.3	0.1	APHA2130B	05/26/00
CW-03-01-000525	ZINC	mg/L	4	<	0.050	0.050	200.7	06/06/00
CW-03-01-000525	GROSS ALPHA*	pCi/L	7		9 +/- 5	7	1, 2, 3, 4, 6, 7, 8	07/18/00
CW-03-01-000525	GROSS BETA*	pCi/L	7		12 +/- 10	7	1, 2, 3, 4, 6, 7, 8	07/18/00
CW-03-01-000525	RADIUM 226*	pCi/L	8,9		0.0 +/- 0.1	0.1	1, 2, 3, 4, 5, 8, 9	07/03/00
CW-03-01-000525	RADIUM 228*	pCi/L	8,9		2.4 +/- 0.7	0.4	1, 2, 3, 8	06/13/00
CW-03-01-000525	URANIUM*	mg/L	8,9		0.0020	0.0001	18	06/17/00
CW-03-01-000525	RADON*	pCi/L			120 +/- 27	53	4, 5	05-27-00

*See attached list of method references

CATIONS	10.23
ANIONS	8.84
%DIFFERENCE	3.65

Karl W. McCrea
Laboratory Director

This report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAL ENVIRONMENTAL LLC

CLIENT: City of Fallon c/o Shepherd-Miller Inc.
AAL REF: EV5480
ATTN: Tim Runnells

ANALYSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER		DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
CW-03-01-000525	RADON	pCi/L		81 +/- 22	44	4, 5*	05-27-00

*See attached list of method references

Karl W. McCrea
Laboratory Director

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AAL ENVIRONMENT LLC

CLIENT: City of Fallon c/o Stephen Miller Inc.
AAL REF: EV5480
ATTN: Tim Runnells
ANALYSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER				Replicate	Percent Difference	METHOD DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
CW-01-01-000525	ALKALINITY, TOTAL	mg/L	1		223		221	0.2	1	APHA2320B	05/31/00
CW-01-01-000525	ALKALINITY, BICARBONATE	mg/L	1		170		169	0.1	1	APHA2320B	05/31/00
CW-01-01-000525	ALKALINITY, CARBONATE	mg/L	1		53		53	0.0	1	APHA2320B	05/31/00
CW-01-01-000525	ALKALINITY, HYDROXIDE	mg/L	1		ND		ND	N/A	1	APHA2320B	05/31/00
CW-01-01-000525	ALUMINUM	mg/L	4		0.024		0.025	-1.0	0.020	200.7	06/06/00
CW-01-01-000525	ANTIMONY	mg/L	4	<	0.003	<	0.003	0.0	0.003	200.8	06/15/00
CW-01-01-000525	ARSENIC	mg/L	4		0.114		0.113	0.2	0.005	200.8	06/13/00
CW-01-01-000525	ARSENIC	mg/L	12		0.114		0.110	0.9	0.005	200.8	06/13/00
CW-01-01-000525	ARSENIC	mg/L	5		0.113		0.112	0.2	0.005	200.8	06/13/00
CW-01-01-000525	ARSENIC	mg/L	11		0.109		0.109	0.0	0.005	200.7	06/06/00
CW-01-01-000525	ARSENIC (III)	mg/L	10	<	0.005	<	0.005	0.0	0.005	200.7	06/06/00
CW-01-01-000525	BARIUM	mg/L	4	<	0.020	<	0.020	0.0	0.020	200.7	06/06/00
CW-01-01-000525	BERYLLIUM	mg/L	4	<	0.002	<	0.002	0.0	0.002	200.8	06/06/00
CW-01-01-000525	CADMIUM	mg/L	4	<	0.002	<	0.002	0.0	0.002	200.8	06/13/00
CW-01-01-000525	CALCIUM	mg/L	1		1.37		1.41	-0.7	0.50	200.7	06/06/00
CW-01-01-000525	CHLORIDE	mg/L	1		98.1		101	-0.7	0.2	300.0	06/18/00
CW-01-01-000525	CHROMIUM	mg/L	4	<	0.005	<	0.005	0.0	0.005	200.8	06/06/00
CW-01-01-000525	CHROMIUM	mg/L	5	<	0.005	<	0.005	0.0	0.005	200.8	06/06/00
CW-01-01-000525	COLOR - APPARENT	c.u.	1		5-10		N/A	N/A	5	APHA2120B	05/26/00
CW-01-01-000525	COPPER	mg/L	4	<	0.010	<	0.010	0.0	0.010	200.8	06/06/00
CW-01-01-000525	FLUORIDE	mg/L	1		0.614		0.638	-1.0	0.1	300.0	06/18/00
CW-01-01-000525	IRON	mg/L	4	<	0.020	<	0.020	0.0	0.020	200.7	06/14/00
CW-01-01-000525	LEAD	mg/L	4	<	0.007	<	0.007	0.0	0.007	200.8	06/13/00
CW-01-01-000525	MAGNESIUM	mg/L	1		0.57		0.57	0.0	0.10	200.7	06/06/00
CW-01-01-000525	MANGANESE	mg/L	4	<	0.005	<	0.005	0.0	0.005	200.7	06/06/00
[illegible]-01-000525	MERCURY	mg/L	4	<	0.0005	<	0.0005	0.0	0.0005	245.1	06/05/00
[illegible]-01-000525	NICKEL	mg/L	4	<	0.020	<	0.020	0.0	0.020	200.7	06/13/00
Cw-01-01-000525	NITRATE / NITRITE as N	mg/L	3	<	2.0	<	2.0	0.0	0.1	300.0	06/18/00
CW-01-01-000525	NITRATE as N	mg/L	1		0.384		0.361	1.5	0.1	300.0	06/18/00
CW-01-01-000525	NITRITE as N	mg/L	1		3.16		3.19	-0.2	0.1	300.0	06/18/00
CW-01-01-000525	pH	s.u.	1		9.50		N/A	N/A	0.01	APHA4500H+B	05/26/00
CW-01-01-000525	POTASSIUM	mg/L	1		10.7		10.6	0.2	0.10	200.7	06/06/00
CW-01-01-000525	SELENIUM	mg/L	4		0.023		0.024	-1.1	0.010	200.7	06/15/00
CW-01-01-000525	SILICA	mg/L	1		34.2		34.0	0.1	0.025	200.7	06/06/00
CW-01-01-000525	SILVER	mg/L	4	<	0.010	<	0.010	0.0	0.010	200.8	06/13/00
CW-01-01-000525	SODIUM	mg/L	1		220		218	0.2	0.50	200.7	06/06/00
CW-01-01-000525	SULFATE	mg/L	1		83.6		87.2	-1.1	0.4	300.0	06/18/00
CW-01-01-000525	TDS	mg/L	1		514		580	-3.0	10	APHA2540C	05/30/00
CW-01-01-000525	THALLIUM	mg/L	4	<	0.001	<	0.001	0.0	0.001	200.8	06/13/00
CW-01-01-000525	TSS	mg/L	1	<	2		N/A	N/A	2	APHA2540D	05/26/00
CW-01-01-000525	TURBIDITY	NTU	1		0.5		N/A	N/A	0.1	APHA2130B	05/26/00
CW-01-01-000525	ZINC	mg/L	4	<	0.050	<	0.050	0.0	0.050	200.7	06/06/00
38413-6809	GROSS ALPHA	pCi/L	N/A		551.6 +/-32.6		590.3 +/- 33.7	6.7	5	1, 2, 3, 4, 6, 7, 8	07/18/00
38413-6809	GROSS BETA	pCi/L	N/A		429.0 +/- 21.1		457.9 +/- 21.6	6.5	2	1, 2, 3, 4, 6, 7, 8	07/18/00
38413-9273	RADIUM 226	pCi/L	N/A		0.011 +/- .084		0.124 +/- 0.094	16.7	0.1	1, 2, 3, 4, 5, 8, 9	06/20/00
38413-9703	RADIUM 228	pCi/L	N/A		0.73 +/- 0.514		0.615 +/- 0.538	1.7	0.3	1, 2, 3, 8	06/13/00
38413-9125	URANIUM	mg/L	N/A		0.8162 +/- 0.0265		0.8292 +/- .0274	1.5	0.0001	16	06/17/00
38413-9126	RADON	pCi/L	N/A		44.288 +/- 17.42		44.568 +/- 17.53	0.6	49	4, 5	05-27-00

Karl McCrea
Laboratory Director

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AAL ENVIRONMENTAL LLC

CLIENT: City of Fallon c/o Shepherd Miller Inc.
AAL REF: EV5450
ATTN: Tim Runnells
ANALYSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER			DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
CW-01-01-000525	SELENIUM	mg/L	4	<	0.010	0.010	200.8	08/08/00
CW-01-01-000525	THALLIUM	mg/L	4	<	0.001	0.001	200.8	08/08/00

*See attached list of method references

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER			DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
CW-01-02-000525	SELENIUM	mg/L	4	<	0.010	0.010	200.8	08/08/00
CW-01-02-000525	THALLIUM	mg/L	4	<	0.001	0.001	200.8	08/08/00

*See attached list of method references

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER			DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
CW-03-01-000525	SELENIUM	mg/L	4	<	0.010	0.010	200.8	08/08/00
CW-03-01-000525	THALLIUM	mg/L	4	<	0.001	0.001	200.8	08/08/00

*See attached list of method references

KWM

Karl W. McCrea
Laboratory Director

his report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAL ENVIRONMENTAL LLC

AAL ENVIRONMENTAL LLC

Sparks Office
1500 Glendale Ave.
Nevada 89431
Box 11530
Reno NV 89510
(775) 356-0606
Fax
(775) 356-1413

Final

REPORT OF ANALYSIS

Client:	**City of Fallon c/o Shepherd-Miller Inc.** Tim Runnells
Project:	
AAL Ref:	EV5485
Report Date:	08-09-00
Samples received by:	K.McCrea
Date Received:	05-26-00
Time Received:	3:30 p.m.
Conditions:	Samples were delived to lab in good condition by T. Runnells. Temperature upon reception was 19.2C.

Samples Received: 2 water samples for analysis as requested

Samples Labeled:

CW-04-01-000526
CW-04-03-000526

This report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report is for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

CLIENT: City of Paton c/o Shepherd-Miller Inc.
AAL REF: EV5485
ATTN: Tim Runnells
ANALYSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER			DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
CW-04-01-000526	ALKALINITY, TOTAL	mg/L	1		222	1	APHA2320B	05/31/00
CW-04-01-000526	ALKALINITY, BICARBONATE	mg/L	1		168	1	APHA2320B	05/31/00
CW-04-01-000526	ALKALINITY, CARBONATE	mg/L	1		54	1	APHA2320B	05/31/00
CW-04-01-000526	ALKALINITY, HYDROXIDE	mg/L	1		ND	1	APHA2320B	05/31/00
CW-04-01-000526	ALUMINUM	mg/L	4	<	0.020	0.020	200.7	06/06/00
CW-04-01-000526	ANTIMONY	mg/L	4	<	0.003	0.003	200.8	06/13/00
CW-04-01-000526	ARSENIC	mg/L	4		0.13	0.005	200.8	06/13/00
CW-04-01-000526	ARSENIC	mg/L	12		0.099	0.005	200.8	06/13/00
CW-04-01-000526	ARSENIC	mg/L	5		0.103	0.005	200.8	06/13/00
CW-04-01-000526	ARSENIC	mg/L	11		0.110	0.005	200.7	05/26/00
CW-04-01-000526	ARSENIC (III)	mg/L	10	<	0.005	0.005	200.7	05/26/00
CW-04-01-000526	BARIUM	mg/L	4	<	0.020	0.020	200.7	06/06/00
CW-04-01-000526	BERYLLIUM	mg/L	4	<	0.002	0.002	200.7	06/06/00
CW-04-01-000526	CADMIUM	mg/L	4	<	0.002	0.002	200.8	06/13/00
CW-04-01-000526	CALCIUM	mg/L	1		1.40	0.50	200.7	06/06/00
CW-04-01-000526	CHLORIDE	mg/L	1		106	0.2	300.0	06/16/00
CW-04-01-000526	CHROMIUM	mg/L	4	<	0.005	0.005	200.7	06/06/00
CW-04-01-000526	CHROMIUM	mg/L	5	<	0.005	0.005	200.7	06/06/00
CW-04-01-000526	COLOR - APPARENT	c.u.	1		5-10	5	APHA2120B	05/26/00
CW-04-01-000526	COPPER	mg/L	4	<	0.010	0.010	200.7	06/06/00
CW-04-01-000526	FLUORIDE	mg/L	1		0.7	0.1	300.0	05/26/00
CW-04-01-000526	IRON	mg/L	4	<	0.020	0.020	200.7	06/06/00
CW-04-01-000526	LEAD	mg/L	4	<	0.007	0.007	200.8	06/13/00
CW-04-01-000526	MAGNESIUM	mg/L	1		0.654	0.10	200.7	06/06/00
CW-04-01-000526	MANGANESE	mg/L	4	<	0.005	0.005	200.7	06/06/00
CW-04-01-000526	MERCURY	mg/L	4	<	0.0005	0.0005	245.1	06/05/00
CW-04-01-000526	NICKEL	mg/L	4	<	0.020	0.020	200.8	06/13/00
CW-04-01-000526	NITRATE / NITRITE as N	mg/L	3	<	2.0	2.0	300.0	06/18/00
CW-04-01-000526	NITRATE as N	mg/L	1		0.4	0.1	300.0	05/26/00
CW-04-01-000526	NITRITE as N	mg/L	1	<	0.1	0.1	300.0	05/26/00
CW-04-01-000526	pH	s.u.	1		9.50	0.01	APHA4500H+B	05/26/00
CW-04-01-000526	POTASSIUM	mg/L	1		11.8	0.10	200.7	06/06/00
CW-04-01-000526	SELENIUM	mg/L	4		0.042	0.010	200.8	06/13/00
CW-04-01-000526	SILICA	mg/L	1		15.7	0.025	200.7	06/06/00
CW-04-01-000526	SILVER	mg/L	4	<	0.010	0.010	200.8	06/13/00
CW-04-01-000526	SODIUM	mg/L	1		240	0.50	200.7	06/06/00
CW-04-01-000526	SULFATE	mg/L	1		89.9	0.4	300.0	06/16/00
CW-04-01-000526	TDS	mg/L	1		548	10	APHA2540C	06/01/00
CW-04-01-000526	THALLIUM	mg/L	4	<	0.001	0.001	200.8	06/13/00
CW-04-01-000526	TSS	mg/L	1	<	2	2	APHA2540D	05/30/00
CW-04-01-000526	TURBIDITY	NTU	1		0.1	0.1	APHA2130B	05/26/00
CW-04-01-000526	ZINC	mg/L	4	<	0.050	0.050	200.7	06/06/00
CW-04-01-000526	GROSS ALPHA*	pCi/L	7		9 +/- 6	4	1,2,3,4,6,7,8	07/18/00
CW-04-01-000526	GROSS BETA*	pCi/L	7		12 +/- 4	2	1,2,3,4,6,7,8	07/18/00
CW-04-01-000526	RADIUM 226*	pCi/L	8,9		0.1 +/- 0.1	0.5	1,2,3,4,5,8,9	07/06/00
CW-04-01-000526	RADIUM 228*	pCi/L	8,9		1.3 +/- 0.5	0.3	1,2,3,8	06/07/00
CW-04-01-000526	URANIUM*	mg/L	8,9		0.0021	0.0001	16	06/17/00
CW-04-01-000526	RADON*	pCi/L			81 +/- 22	44	4, 5	05-27-00

*See attached list of method references

CATIONS	10.9
ANIONS	9.59
%DIFFERENCE	12.4

Karl W. McCrea
Laboratory Director

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AAL ENVIRONMENTAL LLC

CLIENT: City of Fallon c/o Shepherd-Miller Inc.
AAL REF: EV5485
ATTN: Tim Runnells

ANALYSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER			DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
CW-04-03-000527	ALKALINITY, TOTAL	mg/L	1	<	1	1	APHA2320B	06/05/00
CW-04-03-000527	ALKALINITY, BICARBONATE	mg/L	1	<	1	1	APHA2320B	06/05/00
CW-04-03-000527	ALKALINITY, CARBONATE	mg/L	1		ND	1	APHA2320B	06/05/00
CW-04-03-000527	ALKALINITY, HYDROXIDE	mg/L	1		ND	1	APHA2320B	06/05/00
CW-04-03-000527	ALUMINUM	mg/L	4	<	0.020	0.020	200.7	06/06/00
CW-04-03-000527	ANTIMONY	mg/L	4	<	0.003	0.003	200.8	06/13/00
CW-04-03-000527	ARSENIC	mg/L	4	<	0.005	0.005	200.8	06/13/00
CW-04-03-000527	ARSENIC	mg/L	12	<	0.005	0.005	200.8	06/15/00
CW-04-03-000527	ARSENIC	mg/L	5	<	0.005	0.005	200.8	06/13/00
CW-04-03-000527	ARSENIC	mg/L	11	<	0.005	0.005	200.7	05/26/00
CW-04-03-000527	ARSENIC (III)	mg/L	10	<	0.005	0.005	200.7	05/26/00
CW-04-03-000527	BARIUM	mg/L	4	<	0.020	0.020	200.7	06/06/00
CW-04-03-000527	BERYLLIUM	mg/L	4	<	0.002	0.002	200.7	06/06/00
CW-04-03-000527	CADMIUM	mg/L	4	<	0.002	0.002	200.8	06/13/00
CW-04-03-000527	CALCIUM	mg/L	1	<	0.50	0.50	200.7	06/06/00
CW-04-03-000527	CHLORIDE	mg/L	1		6.8	0.2	300.0	05/26/00
CW-04-03-000527	CHROMIUM	mg/L	4	<	0.005	0.005	200.7	06/06/00
CW-04-03-000527	CHROMIUM	mg/L	5	<	0.005	0.005	200.7	06/06/00
CW-04-03-000527	COLOR - APPARENT	c.u.	1		5-10	5	APHA2120B	05/26/00
CW-04-03-000527	COPPER	mg/L	4	<	0.010	0.010	200.7	06/06/00
CW-04-03-000527	FLUORIDE	mg/L	1	<	0.1	0.1	300.0	05/26/00
CW-04-03-000527	IRON	mg/L	4	<	0.020	0.020	200.7	06/06/00
CW-04-03-000527	LEAD	mg/L	4	<	0.007	0.007	200.8	06/13/00
CW-04-03-000527	MAGNESIUM	mg/L	1	<	0.10	0.10	200.7	06/06/00
CW-04-03-000527	MANGANESE	mg/L	4	<	0.005	0.005	200.7	06/06/00
CW-04-03-000527	MERCURY	mg/L	4	<	0.0005	0.0005	245.1	06/05/00
CW-04-03-000527	NICKEL	mg/L	4	<	0.020	0.020	200.8	06/13/00
CW-04-03-000527	NITRATE / NITRITE as N	mg/L	3	<	2.0	0.1	300.0	06/18/00
CW-04-03-000527	NITRATE as N	mg/L	1	<	0.1	0.1	300.0	05/26/00
CW-04-03-000527	NITRITE as N	mg/L	1	<	0.1	0.1	300.0	05/26/00
CW-04-03-000527	pH	s.u.	1		6.04	0.01	APHA4500H+B	05/26/00
CW-04-03-000527	POTASSIUM	mg/L	1	<	0.10	0.10	200.7	06/06/00
CW-04-03-000527	SELENIUM	mg/L	4	<	0.010	0.010	200.8	06/13/00
CW-04-03-000527	SILICA	mg/L	1		0.109	0.025	200.7	06/06/00
CW-04-03-000527	SILVER	mg/L	4	<	0.010	0.010	200.8	06/13/00
CW-04-03-000527	SODIUM	mg/L	1	<	0.50	0.50	200.7	06/06/00
CW-04-03-000527	SULFATE	mg/L	1		5.9	0.4	300.0	05/26/00
CW-04-03-000527	TDS	mg/L	1	<	10	10	APHA2540C	06/01/00
CW-04-03-000527	THALLIUM	mg/L	4	<	0.001	0.001	200.8	06/13/00
CW-04-03-000527	TSS	mg/L	1	<	2	2	APHA2540D	05/30/00
CW-04-03-000527	TURBIDITY	NTU	1	<	0.1	0.1	APHA2130B	05/26/00
CW-04-03-000527	ZINC	mg/L	4	<	0.050	0.050	200.7	06/06/00
CW-04-03-000527	GRCSS ALPHA	pCi/L	7		1 +/- 0	0	1,2,3,4,6,7,8	07/18/00
CW-04-03-000527	GRCSS BETA	pCi/L	7		1 +/- 1	0	1,2,3,4,6,7,8	07/18/00
CW-04-03-000527	RADIUM 226	pCi/L	8,9		0.1 +/- 0.1	0.4	1,2,3,4,5,8,9	07/06/00
CW-04-03-000527	RADIUM 228	pCi/L	8,9		.07 +/- 0.5	0.3	1,2,3,8	06/07/00
CW-04-03-000527	URANIUM	mg/L	8,9	<	0.0001	0.0001	16	06/17/00
CW-04-03-000527	RADON	pCi/L						

CATIONS	0.06
ANIONS	0.32
%DIFFERENCE	139.1

Karl W. McCrea
Laboratory Director

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AAL ENVIRONMENTAL LLC

CLIENT: City of Fallon c/o Shepherd Miller Inc.
AAL REF: EV5485
ATTN: Tim Runnells
ANALYSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER			DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
CW-04-01-000526	SELENIUM	mg/L	4	<	0.010	0.010	200.8	08/08/00
CW-04-01-000526	THALLIUM	mg/L	4	<	0.001	0.001	200.8	08/08/00

Re-analysis per client request

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER			DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
CW-04-03-000527	SELENIUM	mg/L	4	<	0.010	0.010	200.8	08/08/00
CW-04-03-000527	THALLIUM	mg/L	4	<	0.001	0.001	200.8	08/08/00

Re-analysis per client request

Karl W. McCrea
Laboratory Director

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AAL ENVIRONMENTA LLC

AAL
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LLC

Sparks Office
1500 Glendale Ave.
Nevada 89431
Box 11530
Reno NV 89510
(775) 356-0606
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(775) 356-1413

Final

REPORT OF ANALYSIS

Client:	**City of Fallon c/o Shepherd-Miller Inc.** Tim Runnells
Project:	
AAL Ref:	EV5566
Report Date:	07-06-00
Samples received by:	G. Ryan
Date Received:	06-27-00
Time Received:	8:30 a.m.
Conditions:	Samples retreived from cold storage. Client requested additional analysis on previous job EV5485 on 6-27-00.
Samples Received:	2 water samples for Ortho Phosphorous

Samples Labeled:

CW-04-01-000526
CW-04-03-000526

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CLIENT: City of Fallon c/o Shepherd-Miller Inc.
AAL REF: EV5566
ATTN: Tim Runnells
ANALYSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER			DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
CW-04-01-000526	PHOSPHOROUS, ORTHO	mg/L	1		0.83	0.25	APHA4500P+C	06/30/00
CW-04-03-000526	PHOSPHOROUS, ORTHO	mg/L	1	<	0.25	0.25	APHA4500P+C	06/30/00

Requested past recommended hold time. Analyzed past recommended hold time.

Karl W. McCrea
Laboratory Director

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AAL ENVIRONMENTAL LLC

CLIENT: City of Fallon c/o Shepherd-Miller Inc.
AAL REF:
ATTN: Tim Runnells
ANALYSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER		Replicate	Percent Recovery	METHOD DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
LFB	ALKALINITY, TOTAL	mg/L	1	N/A	N/A	N/A	1	APHA2320B	05/31/00
LFB	ALUMINUM	mg/L	4	2.38	2.50	95.2%	0.020	200.7	06/06/00
LFB	ANTIMONY	mg/L	4	0.090	0.100	90.0%	0.003	200.8	06/15/00
LFB	ARSENIC	mg/L	4	2.35	2.50	94.0%	0.005	200.8	06/13/00
LFB	ARSENIC	mg/L	10, 11	2.82	2.5	112.8%	0.005	200.7	06/06/00
LFB	BARIUM	mg/L	4	4.88	5.00	97.6%	0.020	200.7	06/06/00
LFB	BERYLLIUM	mg/L	4	0.101	0.100	101.0%	0.002	200.8	06/06/00
LFB	CADMIUM	mg/L	4	0.0976	0.100	97.6%	0.002	200.8	06/13/00
LFB	CALCIUM	mg/L	1	49.6	50.0	99.2%	0.50	200.7	06/06/00
LFB	CHLORIDE	mg/L	1	3.12	3.00	104.0%	0.2	300.0	06/18/00
LFB	CHROMIUM	mg/L	4	0.0998	0.100	99.8%	0.005	200.7	06/06/00
	COLOR - APPARENT	c.u.	1	N/A	N/A	N/A	5	APHA2120B	05/26/00
LFB	COPPER	mg/L	4	0.920	0.100	920.0%	0.010	200.8	06/06/00
LFB	FLUORIDE	mg/L	1	2.07	2.00	103.7%	0.1	300.0	06/18/00
LFB	IRON	mg/L	4	2.40	2.50	96.0%	0.020	200.7	06/14/00
LFB	LEAD	mg/L	4	0.0871	0.100	87.1%	0.007	200.8	06/13/00
LFB	MAGNESIUM	mg/L	1	48.2	50.0	96.4%	0.10	200.7	06/06/00
LFB	MANGANESE	mg/L	4	2.40	2.50	96.0%	0.005	200.7	06/06/00
LFB	MERCURY	ug/L	4	2.67	2.50	106.8%	0.0005	245.1	06/05/00
LFB	NICKEL	mg/L	4	0.097	0.100	96.5%	0.020	200.7	06/13/00
LFB	NITRATE / NITRITE as N	mg/L	3	5.54	5.50	100.8%	0.1	300.0	06/18/00
LFB	NITRATE as N	mg/L	1	2.64	2.50	105.6%	0.1	300.0	06/18/00
	NITRITE as N	mg/L	1	3.19	3.00	106.3%	0.1	300.0	06/18/00
	pH	s.u.	1	N/A	N/A	N/A	0.01	APHA4500H+B	05/26/00
LFB	POTASSIUM	mg/L	1	55.9	50.0	111.8%	0.10	200.7	06/06/00
LFB	SELENIUM	mg/L	4	2.42	2.50	96.8%	0.010	200.8	06/15/00
	SILICA	mg/L	1	N/A	N/A	N/A	0.025	200.7	06/06/00
LFB	SILVER	mg/L	4	0.048	0.050	96.8%	0.010	200.8	06/13/00
LFB	SODIUM	mg/L	1	50.5	50.0	101.0%	0.50	200.7	06/06/00
LFB	SULFATE	mg/L	1	15.7	15.0	104.7%	0.4	300.0	06/18/00
	TDS	mg/L	1	N/A	N/A	N/A	10	APHA2540C	05/30/00
LFB	THALLIUM	mg/L	4	0.107	0.100	107.0%	0.001	200.8	06/13/00
	TSS	mg/L	1	N/A	N/A	N/A	2	APHA2540D	05/26/00
	TURBIDITY	NTU	1	N/A	N/A	N/A	0.1	APHA2130B	05/06/00
LFB	ZINC	mg/L	4	0.099	0.100	99.4%	0.050	200.7	06/06/00

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AAL ENVIRONMENTA LLC

CLIENT: City of Fallon C/o Shepherd Miller, Inc.
AAL REF:
ATTN: Tim Rutnetts

AN''YSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER		Replicate	Percent Recovery	METHOD DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
WP82	ALKALINITY, TOTAL	mg/L	1	95.6	95.7	99.9%	1	APHA2320B	05/30/00
QCS9988	ALUMINUM	mg/L	4	0.864	0.790	109.4%	0.020	200.7	06/06/00
QCS9988	ANTIMONY	mg/L	4	0.152	0.167	91.0%	0.003	200.8	06/15/00
QCS9988	ARSENIC	mg/L	4	0.0824	0.109	75.6%	0.005	200.8	06/13/00
QCS9988	ARSENIC	mg/L	10, 11	0.107	0.109	98.2%	0.005	200.7	05/26/00
QCS9988	BARIUM	mg/L	4	1.13	0.992	113.9%	0.020	200.7	06/06/00
QCS9988	BERYLLIUM	mg/L	4	0.193	0.183	105.5%	0.002	200.8	06/06/00
QCS9988	CADMIUM	mg/L	4	0.204	0.216	94.4%	0.002	200.8	06/13/00
QCS9988	CALCIUM	mg/L	1	25.0	23.4	106.8%	0.50	200.7	06/06/00
QCS Anions#727	CHLORIDE	mg/L	1	26.99	24.7	109.3%	0.2	300.0	06/18/00
QCS9988	CHROMIUM	mg/L	4	0.399	0.361	110.5%	0.005	200.7	06/06/00
	COLOR - APPARENT	c.u.	1	N/A	N/A	N/A	5	APHA2120B	05/26/00
QCS9988	COPPER	mg/L	4	0.060	0.053	112.0%	0.010	200.8	06/06/00
QCS Anions#727	FLUORIDE	mg/L	1	4.277	3.97	107.7%	0.1	300.0	06/18/00
QCS9988	IRON	mg/L	4	0.342	0.295	115.9%	0.020	200.7	06/14/00
QCS9988	LEAD	mg/L	4	0.0502	0.0735	68.3%	0.007	200.8	06/13/00
QCS9988	MAGNESIUM	mg/L	1	28.7	27.7	103.6%	0.10	200.7	06/06/00
QCS9988	MANGANESE	mg/L	4	0.266	0.233	114.2%	0.005	200.7	06/06/00
WP55	MERCURY	ug/L	4	3.90	3.72	104.8%	0.0005	245.1	06/02/00
QCS9988	NICKEL	mg/L	4	0.639	0.674	94.8%	0.020	200.7	06/13/00
RDL	NITRATE / NITRITE as N	mg/L	3	2.02	2.0	100.9%	0.1	300.0	06/18/00
QCS Anions#727	NITRATE as N	mg/L	1	16.2	14.9	108.8%	0.1	300.0	06/18/00
C[illegible] nions#727	NITRITE as N	mg/L	1	1.40	1.50	93.3%	0.1	300.0	06/18/00
[illegible]5	pH	s.u.	1	5.92	5.90	100.3%	0.01	APHA4500H+B	05/26/00
QCS o-P 87	PHOSPHOROUS, ORTHO	mg/L	1	3.09	3.00	103.0%	0.25	APHA	06/30/00
QCS9988	POTASSIUM	mg/L	1	42.4	41.2	102.9%	0.10	200.7	06/06/00
QCS9988	SELENIUM	mg/L	4	0.168	0.174	96.6%	0.010	200.8	06/15/00
	SILICA	mg/L	1	N/A	N/A	N/A	0.025	200.7	06/06/00
QCS9988	SILVER	mg/L	4	0.150	0.211	71.1%	0.010	200.8	06/13/00
QCS9988	SODIUM	mg/L	1	63.7	61.5	103.6%	0.50	200.7	06/06/00
QCS Anions#727	SULFATE	mg/L	1	35.1	34.5	101.7%	0.4	300.0	06/18/00
	TDS	mg/L	1	760	781	97.3%	10	APHA2540C	05/30/00
QCS9988	THALLIUM	mg/L	4	0.074	0.076	97.8%	0.001	200.8	06/13/00
QC99101	TSS	mg/L	1	47.2	50.3	93.8%	2	APHA2540D	05/26/00
	TURBIDITY	NTU	1	N/A	N/A	N/A	0.1	APHA2130B	05/06/00
QCS9988	ZINC	mg/L	4	0.843	0.768	109.8%	0.050	200.7	06/06/00

LCS did not pass requirements for As, Pb and Ag for EPA200.8; Cu and Fe for EPA200.7. This particular LCS sample has since been replaced.

'is report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report 'or the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAL ENVIRONMENTA LLC

CLIENT: City of Fallon c/o Shepherd-Miller Inc
AAL REF:
ATTN: Tim Runnells

YSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER			METHOD DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
LRB	ALKALINITY, TOTAL	mg/L	1	<	1	1	APHA2320B	05/31/00
LRB	ALUMINUM	mg/L	4	<	0.020	0.020	200.7	06/06/00
LRB	ANTIMONY	mg/L	4	<	0.003	0.003	200.8	06/15/00
LRB	ARSENIC	mg/L	4	<	0.005	0.005	200.8	06/13/00
LRB	ARSENIC	mg/L	10, 11	<	0.005	0.005	200.7	06/06/00
LRB	BARIUM	mg/L	4	<	0.020	0.020	200.7	06/06/00
LRB	BERYLLIUM	mg/L	4	<	0.002	0.002	200.8	06/06/00
LRB	CADMIUM	mg/L	4	<	0.002	0.002	200.8	06/13/00
LRB	CALCIUM	mg/L	1	<	0.50	0.50	200.7	06/06/00
LRB	CHLORIDE	mg/L	1	<	0.2	0.2	300.0	06/18/00
LRB	CHROMIUM	mg/L	4	<	0.005	0.005	200.7	06/06/00
LRB	COLOR - APPARENT	c.u.	1		5	5	APHA2120B	05/26/00
LRB	COPPER	mg/L	4	<	0.010	0.010	200.8	06/06/00
LRB	FLUORIDE	mg/L	1	<	0.1	0.1	300.0	06/18/00
LRB	IRON	mg/L	4	<	0.020	0.020	200.7	06/14/00
LRB	LEAD	mg/L	4	<	0.007	0.007	200.8	06/13/00
LRB	MAGNESIUM	mg/L	1	<	0.10	0.10	200.7	06/06/00
[illegible]	MANGANESE	mg/L	4	<	0.005	0.005	200.7	06/06/00
[illegible]	MERCURY	ug/L	4	<	0.0005	0.0005	245.1	06/05/00
LRB	NICKEL	mg/L	4	<	0.020	0.020	200.7	06/13/00
LRB	NITRATE / NITRITE as N	mg/L	3		0.1	0.1	300.0	06/18/00
LRB	NITRATE as N	mg/L	1	<	0.1	0.1	300.0	06/18/00
LRB	NITRITE as N	mg/L	1	<	0.1	0.1	300.0	06/18/00
LRB	pH	s.u.	1		5.96	0.01	APHA4500H+B	05/26/00
LRB	POTASSIUM	mg/L	1	<	0.10	0.10	200.7	06/06/00
LRB	SELENIUM	mg/L	4	<	0.010	0.010	200.8	06/15/00
LRB	SILICA	mg/L	1	<	0.025	0.025	200.7	06/06/00
LRB	SILVER	mg/L	4	<	0.010	0.010	200.8	06/13/00
LRB	SODIUM	mg/L	1	<	0.50	0.50	200.7	06/06/00
LRB	SULFATE	mg/L	1	<	0.4	0.4	300.0	06/18/00
LRB	TDS	mg/L	1	<	10	10	APHA2540C	05/30/00
LRB	THALLIUM	mg/L	4	<	0.001	0.001	200.8	06/13/00
LRB	TSS	mg/L	1		2	2	APHA2540D	05/26/00
LRB	TURBIDITY	NTU	1		0.2	0.1	APHA2130B	05/06/00
LRB	ZINC	mg/L	4	<	0.050	0.050	200.7	06/06/00

is report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAL ENVIRONMENTA LLC

CLIENT: City of Fallon c/o Shepard-Miller Inc.
AAL REF:
ATTN: Tom Rumbelle

Report of Blank Analysis

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER		EPA METHOD
QA for EV5466					
Acculabs #38413	Gross Alpha	pCi/L	7	0.390 +/- 0.18	1,2,3,4,6,7,8
Acculabs #38413	Gross Beta	pCi/L	7	0.64 +/- 0.420	1,2,3,4,6,7,8
Acculabs #38413	Ra-226	pCi/L	8,9	-0.012 +/- 0.089	1,2,3,4,6,7,8
Acculabs #38413	Ra-228	pCi/L	8,9	1.067 +/- 0.696	1,2,3,8
Acculabs #38413	Uranium (kpa)	uG/L	8,9	-0.0092 +/- 0.00028	16

his report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAL ENVIRONM LLC

CLIENT: City of Fallon C/o Shepherd-Miller Inc.
AAL REF:
ATTN: Tim Rundells

Report of Decision Level Concentration

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER	9125	9126	EPA METHOD
QA for EV5466						
Acculabs #38413	Gross Alpha	pCi/L	7	6.04	---	1,2,3,4,6,7,8
Acculabs #38413	Gross Beta	pCi/L	7	2.68	---	1,2,3,4,6,7,8
Acculabs #38413	Ra-226	pCi/L	8,9	0.465	---	1,2,3,4,6,7,8
Acculabs #38413	Ra-228	pCi/L	8,9	0.32	---	1,2,3,8
Acculabs #38413	Uranium (kpa)	uG/L	8,9	0.0614	---	16
Acculabs #38413	Rn-222	uG/L		---	38.23	

is report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAL ENVIRONMEN LLC

CLIENT: City of Fallon c/o Shepherd-Miller Inc.
AAI REF:
ATTN: Tim Rinnella

Report of Laboratory Control Sample

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER		TRUE VALUE	Percent Recovery	EPA METHOD
QA for EV5466							
Acculabs #38413	Gross Alpha	pCi/L	7	414	439.0	94.3%	1,2,3,4,6,7,8
Acculabs #38413	Gross Beta	pCi/L	7	701	641.00	109.4%	1,2,3,4,6,7,8
Acculabs #38413	Ra-226	pCi/L	8,9	2642	2978	88.7%	1,2,3,4,6,7,8
Acculabs #38413	Ra-228	pCi/L	8,9	2591	2848.8	91.0%	1,2,3,8
Acculabs #38413	Uranium (kpa)	uG/L	8,9	27.9	30.06	92.8%	16

his report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAI ENVIRONM LLC

CLIENT: City of Fallon c/o Stantec Heller Inc.
CONTACT:
ATTN: Tim Runnels

Report of Replicate Analysis

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER		TRUE VALUE	RER*	EPA METHOD
QA for EV5466							
Acculabs #38413	Gross Alpha	pCi/L	7	551.6 +/- 32.6	590.3 +/- 33.7	0.584	1,2,3,4,6,7,8
Acculabs #38413	Gross Beta	pCi/L	7	429 +/- 21.1	457.9 +/- 21.6	0.677	1,2,3,4,6,7,8
Acculabs #38413	Ra-226	pCi/L	8,9	0.011 +/- 0.084	0.124 +/- 0.094	0.635	1,2,3,4,6,7,8
Acculabs #38413	Ra-228	pCi/L	8,9	0.73 +/- 0.514	0.615 +/- 0.538	0.109	1,2,3,8
Acculabs #38413	Uranium (kpa)	uG/L	8,9	0.8162 +/- 0.0265	0.8292 +/- 0.241	0.241	16
Acculabs #38413	Rn-222	uG/L		44.288 +/- 17.42	44.568 +/- 17.53	0.008	

*RER = Relative Error Ratio
Acceptance Criteria RER <=1

This report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAL ENVIRONMENT LLC

CLIENT: City of Fallon c/o Shepherd Miller Inc
AAL-REF:
ATTN: Tim Ronnells

Report of Laboratory Control Sample

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER		TRUE VALUE	Percent Recovery	EPA METHOD
QA for EV5469							
Acculabs #38523	Gross Alpha	pCi/L	7	36.1 +/-	35.4 +/- 2.7	98.1%	1,2,3,4,6,7,8
Acculabs #38523	Gross Beta	pCi/L	7	38 +/-	38.6 +/- 6.2	101.6%	1,2,3,4,6,7,8
Acculabs #38523	Ra-226	pCi/L	8,9	2978 +/-	2838.00 +/- 841	95.3%	1,2,3,4,6,7,8
Acculabs #38523	Ra-228	pCi/L	8,9	2848.8 +/-	2591 +/- 405	91.0%	1,2,3,8
Acculabs #38523	Uranium (kpa)	uG/L	8,9	30.06 +/-	30 +/- 1.33	99.8%	16

is report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for the report. This report for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAL ENVIRONMENTA LLC

CLIENT: City of Fallon c/o Shepherd-Miller Inc.
AAL REF: Tim Runnells

Report of Blank Analysis

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER		EPA METHOD
QA for EV5469					
Acculabs #38523	Gross Alpha	pCi/L	7	0.09 +/- 0.09	1,2,3,4,6,7,8
Acculabs #38523	Gross Beta	pCi/L	7	-0.11 +/- 0.39	1,2,3,4,6,7,8
Acculabs #38523	Ra-226	pCi/L	8,9	0.067 +/- 0.085	1,2,3,4,6,7,8
Acculabs #38523	Ra-228	pCi/L	8,9	1.067 +/- 0.696	1,2,3,8
Acculabs #38523	Uranium (kpa)	uG/L	8,9	-0.0057 +/- 0.00093	16

is report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAL ENVIRONMENTAL LLC

CLIENT: City of Fallon c/o Shepherd-Miller Inc.
AAL REF:
ATTN: Tim Runnells

Report of Decision Level Concentration

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER	9406	9407	EPA METHOD
QA for EV5469						
Acculabs #38523	Gross Alpha	pCi/L	7	4.62	4.60	1,2,3,4,6,7,8
Acculabs #38523	Gross Beta	pCi/L	7	2.61	2.61	1,2,3,4,6,7,8
Acculabs #38523	Ra-226	pCi/L	8,9	0.415	0.326	1,2,3,4,6,7,8
Acculabs #38523	Ra-228	pCi/L	8,9	0.32	0.30	1,2,3,8
Acculabs #38523	Uranium (kpa)	uG/L	8,9	0.0902	0.0902	16

his report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAL ENVIRONMENTA LLC

CLIENT: Monroe Shepherd-Miller Inc.
AAL REF:
ATTN: Tim Runnells

AAL ENVIRONMENTAL LLC

Report of Replicate Analysis

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER	9702	9702R	10612	10612R	9703	9703R	9407	9407R	RER*	EPA METH
QA for EV5469													
Acculabs #38600	Gross Alpha	pCi/L	7	8.900 +/- 8.11	15.910 +/- 8.51	---	---	---	---	---	---	0.555	1,2,3,4,6,7,8
Acculabs #38600	Gross Beta	pCi/L	7	12.23 +/- 3.64	14.08 +/- 4.2	---	---	---	---	---	---	0.236	1,2,3,4,6,7,8
Acculabs #38600	Ra-226	pCi/L	8,9	---	---	0.117 +/- 0.1047	0.024 +/- 0.185	---	---	---	---	0.321	1,2,3,4,6,7,8
Acculabs #38600	Ra-228	pCi/L	8,9	---	---	---	---	0.73 +/- 0.514	0.615 +/- 0.538	---	---	0.109	1,2,3,8
Acculabs #38600	Uranium (kpa)	uG/L	8,9	---	---	---	---	---	---	1.9557 +/- 0.0583	2.0157 +/- 0.0595	0.509	16

*RER = Relative Error Ratio
Acceptance Criteria RER <=1

** Represents Duplicate RPD

This report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. The report is for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of this report or its contents.

CLIENT: City of Eaton Dr. Shepherd-Miller Inc.
AAI REF:
SITE: Tim Summers

R[illegible] of Sample Matrix Spike

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER	Result	Spike Value	Percent Recovery	EPA METHOD
QA for EV5480							
Acculabs #38524	Gross Alpha	pCi/L	7	101.5 +/-	119.64 +/- 20.98	117.8	1,2,3,4,6,7,8
Acculabs #38524	Gross Beta	pCi/L	7	151.8 +/-	155.39 +/- 8.72	102.3	1,2,3,4,6,7,8
Acculabs #38524	Ra-226	pCi/L	8,9	2.98 +/-	2.94 +/-	98.7	1,2,3,4,6,7,8
Acculabs #38524	Ra-228	pCi/L	8,9	N/A	N/A	N/A	1,2,3,8
Acculabs #38524	Uranium (kpa)	uG/L	8,9	15.00 +/-	15.85 +/-	105.7	16

This report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAI ENVIRONM LL

CLIENT: City of Fallon Co. Sheppard Mills Inc.
AAL REF:
ATTN: Tim Runnalls

Report of Replicate Analysis

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER		TRUE VALUE	RER*	EPA METHOD
QA for EV5480							
Acculabs #38524	Gross Alpha	pCi/L	7	6.3 +/- 4.92	2.4 +/- 4.41	0.415	1,2,3,4,6,7,8
Acculabs #38524	Gross Beta	pCi/L	7	13.4 +/- 3.54	6.0 +/- 3.16	1.093	1,2,3,4,6,7,8
Acculabs #38524	Ra-226	pCi/L	8,9	0.153 +/- 0.108	0.128 +/- 0.095	0.123	1,2,3,4,6,7,8
Acculabs #38524	Ra-228	pCi/L	8,9	N/A	N/A	N/A	1,2,3,8
Acculabs #38524	Uranium (kpa)	uG/L	8,9	1.9557 +/- 0.0564	1.8257 +/- 0.0542	6.88%**	16

*RER = Relative Error Ratio
Acceptance Criteria RER <=1

** Represents Duplicate RPD

his report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAL ENVIRONMEN LLC

CLIENT: City of Fallon c/o Shepherd Miller Inc.
AAL REF:
ATTN: Tim Runnels

Report of Decision Level Concentration

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER	9413	9414	9415	EPA METHOD
QA for EV5480							
Acculabs #38524	Gross Alpha	pCi/L	7	5.42	5.58	7.08	1,2,3,4,6,7,8
Acculabs #38524	Gross Beta	pCi/L	7	2.5	2.67	6.75	1,2,3,4,6,7,8
Acculabs #38524	Ra-226	pCi/L	8,9	0.105	0.175	0.119	1,2,3,4,6,7,8
Acculabs #38524	Ra-228	pCi/L	8,9	0.32	0.61	0.36	1,2,3,8
Acculabs #38524	Uranium (kpa)	uG/L	8,9	0.0753	0.0753	0.0753	16

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AAL ENVIRONM LLC

CLIENT: City of Falls / Ja Shepherd-Miller Inc
AA REF:
ATTN: Tim Runnells

Report of Laboratory Control Sample

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER		Calculated Value	Percent Recovery	EPA METHOD
QA for EV5480							
Acculabs #38524	Gross Alpha	pCi/L	7	439 +/-	398.74 + /- 41.2	90.8%	1,2,3,4,6,7,8
Acculabs #38524	Gross Beta	pCi/L	7	639 +/-	708.9 +/- 34.77	110.9%	1,2,3,4,6,7,8
Acculabs #38524	Ra-226	pCi/L	8,9	2978 +/-	3114 +/- 922	104.6%	1,2,3,4,6,7,8
Acculabs #38524	Ra-228	pCi/L	8,9	2838.5 +/-	2295.6 +/- 409.2	80.9%	1,2,3,8
Acculabs #38524	Uranium (kpa)	uG/L	8,9	30.06 +/-	30.00 +/- 1.33	99.8%	16

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AAL ENVIRONM LLC

CLIENT: City of Fallon c/o Shepherd-Miller INC
AAL REF:
ATTN: Jim Runnells

Report of Blank Analysis

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER		EPA METHOD
QA for EV5480					
Acculabs #38524	Gross Alpha	pCi/L	7	0.260 +/- 0.16	1,2,3,4,6,7,8
Acculabs #38524	Gross Beta	pCi/L	7	0.71 +/- 0.400	1,2,3,4,6,7,8
Acculabs #38524	Ra-226	pCi/L	8,9	-0.029+-0.071	1,2,3,4,6,7,8
Acculabs #38524	Ra-228	pCi/L	8,9	0.453 +/- 0.536	1,2,3,8
Acculabs #38524	Uranium (kpa)	uG/L	8,9	-0.0057 +/- 0.00093	16

'is report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAL ENVIRONME' LLC

CLIENT: City of Fallon c/o Shepherd-Miller Inc
AAL REP:
ATTN: Tim Runnells

Report of Blank Analysis

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER		EPA METHOD
QA for EV5485					
Acculabs #38600	Gross Alpha	pCi/L	7	0.09 +/- 0.09	1,2,3,4,6,7,8
Acculabs #38600	Gross Beta	pCi/L	7	-0.11 +/- 0.39	1,2,3,4,6,7,8
Acculabs #38600	Ra-226	pCi/L	8,9	0.067 +/- 0.085	1,2,3,4,6,7,8
Acculabs #38600	Ra-228	pCi/L	8,9	1.067 +/- 0.696	1,2,3,8
Acculabs #38600	Uranium (kpa)	uG/L	8,9	-0.0325 +/- 0.00254	16

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AAL ENVIRONMENTA LLC

CLIENT: City of Fallon c/o Shepherd-Miller Inc.
AAL REF:
ATTN: Tim Rundells

Report of Laboratory Control Sample

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER		Calculated Value	Percent Recovery	EPA METHOD
QA for EV5485							
Acculabs #38600	Gross Alpha	pCi/L	7	36.1 +/-	35.4 +/- 2.7	98.1%	1,2,3,4,6,7,8
Acculabs #38600	Gross Beta	pCi/L	7	38 +/-	38.6 +/- 6.2	101.6%	1,2,3,4,6,7,8
Acculabs #38600	Ra-226	pCi/L	8,9	2978 +/-	2838.00 +/- 841	95.3%	1,2,3,4,6,7,8
Acculabs #38600	Ra-228	pCi/L	8,9	2848.8 +/-	2591 +/- 405	91.0%	1,2,3,8
Acculabs #38600	Uranium (kpa)	uG/L	8,9	30.06 +/-	30 +/- 1.33	102.5%	16

This report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report is for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAL ENVIRONMENTAL LLC

CLIENT: City of Fallon c/o Shepherd-Miller Inc.
AAL REF:
ATTN: Jim Ronnells

Report of Decision Level Concentration

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER	9702	9703	EPA METHOD
QA for EV5485						
Acculabs #38600	Gross Alpha	pCi/L	7	3.82	0.370	1,2,3,4,6,7,8
Acculabs #38600	Gross Beta	pCi/L	7	2.26	0.49	1,2,3,4,6,7,8
Acculabs #38600	Ra-226	pCi/L	8,9	0.488	0.396	1,2,3,4,6,7,8
Acculabs #38600	Ra-228	pCi/L	8,9	0.32	0.30	1,2,3,8
Acculabs #38600	Uranium (kpa)	uG/L	8,9	0.0730	0.0818	16

This report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report is for the exclusive use of the client to whom it is addressd and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAL ENVIRONMENTAL LLC

CLIENT: City of Fallon c/o Shaughnessy-Miller Inc.
AAL REF:
ATTN: Tim Runnells

AAL ENVIRONMENTAL LLC

Report of Replicate Analysis

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER	CW-04-01	CW-04-01	10612	10612R	CW-04-03	CW-04-03	9535	9535R]	RER*	EPA METHOD
QA for EV5485													
Accutabs #38600	Gross Alpha	pCi/L	7	8.900 +/- 8.11	15.910 +/- 6.51	---	---	---	---	---	---	0.555	1,2,3,4,6,7,8
Accutabs #38600	Gross Beta	pCi/L	7	12.23 +/- 3.64	14.08 +/- 4.2	---	---	---	---	---	---	0.236	1,2,3,4,6,7,8
Accutabs #38600	Ra-226	pCi/L	8,9	---	---	0.117 +/- 0.1047	0.024 +/- 0.185	---	---	---	---	0.321	1,2,3,4,6,7,8
Accutabs #38600	Ra-228	pCi/L	8,9	---	---	---	---	0.73 +/- 0.514	0.615 +/- 0.538	---	---	0.109	1,2,3,8
Accutabs #38600	Uranium (kpa)	uG/L	8,9	---	---	---	---	---	---	1.2187 +/- 0.0368	1.1978 +/- 0.0364	0.273	16

*RER = Relative Error Ratio
Acceptance Criteria RER <=1

** Represents Duplicate RPD

This report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report is for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

CLIENT: City of Fallon c/o Shepherd-Miller Inc.
AAL REF:
ATTN: Tim Burnells

'YSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

Selenium & Thallium Re-Analysis

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER			METHOD DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
LRB	Selenium	mg/L	4	<	0.010	0.010	EPA200.8	08/08/00
LRB	Thallium	mg/L	4	<	0.001	0.001	EPA200.8	08/08/00

'vs report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

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CLIENT: City of Fallon c/o Stanford Miller Inc.
AAL REF:
ATTN: Tim Rugamis

YSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

Selenium & Thallium Re-Analysis

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER		TRUE VALUE	Percent Recovery	METHOD DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
QCS	Selenium	mg/L	4	0.348	0.311	111.9%	0.010	EPA200.8	08/08/00
QCS	Thallium	mg/L	4	0.730	0.723	101.0%	0.001	EPA200.8	08/08/00

his report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAL ENVIRONMEN LLC

CLIENT: City of Lafayette c/o Shepherd-Miller, Inc.
AAL REF:
ATTN: Lisa Kaminski

A[illegible]YSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

Selenium & Thallium Re-Analysis

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER		Spike Conc	Percent Recovery	METHOD DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
LFB	Selenium	mg/L	4	2.31	2.50	92.4%	0.010	EPA200.8	08/08/00
LFB	Thallium	mg/L	4	0.105	0.100	105.0%	0.001	EPA200.8	08/08/00

his report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAL ENVIRONM[illegible] LLC

CLIENT: City of Fallon c/o Shepherd-Miller Inc.
AAL REF:
ATTN: Tim Runnells
ANALYSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

Selenium & Thallium Re-Analysis

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER		Result	Spike Value	Spike Conc.	Percent Recovery	METHOD DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
CW-04-03-000526	Selenium	mg/L	4	<	0.010	3.03	2.5	120.7	0.010	EPA200.8	08/08/00
CW-04-03-000526	Thallium	mg/L	4	<	0.001	0.106	0.100	105.0	0.001	EPA200.8	08/08/00

AAL ENVIRONMENTAL LLC

This report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report or its contents cannot be given to anyone other than the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

CLIENT: [illegible]
ADDRESS: [illegible]
[illegible]

ANALYSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER		Replicate	Percent Difference	METHOD DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
CW-03-01-000525	NITRATE / NITRITE as N	mg/L	3	5.4	5.3	0.5	0.1	300.0	06/18/00
CW-03-01-000525	PHOSPHOROUS, ORTHO	mg/L	1	0.750	0.775	3.8	0.25	APHA	06/30/00

his report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAL ENVIRONMENTAL LLC

CLIENT: City of Fallon c/o Shepherd-Miller Inc.
AAL REF: EV5466
ATTN: Tim Runnells

ANALYSIS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

AAL ENVIRONMENTAL LLC

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER		Result	Spike Value	Spike Conc.	Percent Recovery	METHOD DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
CW-02-01-000523	NITRATE / NITRITE as N*	mg/L	3	<	2.0	6.6	5.5	103.2	0.2	300.0	06/18/00
CW-03-01-000525	PHOSPHOROUS, ORTHO	mg/L	1		0.22	0.65	0.50	57.0	0.25	APHA	06/30/00

This report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for the report. The report is for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

[redacted]

AN[illegible]IS PERFORMED BY AAL ENVIRONMENTAL LLC - NV00040

Selenium & Thallium Re-Analysis

SAMPLE ID	PARAMETER	UNITS	BOTTLE NUMBER				Replicate	Percent Difference	METHOD DETECTION LIMIT	EPA METHOD	ANALYSIS DATE
CW-03-01-000525	Selenium	mg/L	4	<	0.010	<	0.010	0.0	0.010	EPA200.8	08/08/00
CW-03-01-000525	Thallium	mg/L	4	<	0.001	<	0.001	0.0	0.001	EPA200.8	08/08/00

his report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report for the exclusive use of the client to whom it is addressed and upon the condition that the client assumes all liability for the further distribution of the report or its contents.

AAL ENVIRONMENTA LLC

APPENDIX B

FIELD DATA SHEETS

GROUND WATER SAMPLING DATA SHEET

IDENTIFICATION Project Number: 100623

Sample Location Fallon City well #4 Date 5/26/00 Start Time 0800 Stop time 0945 Page 1 of 1

mple Control Number CW-04-01-000526 Samplers Tim Runnells, Gary Byrett

..EATHER CONDITIONS

Ambient Air Temperature: 70 °C☐ °F☒ Not Measured☒ **Wind:** Heavy☐ Moderate☐ Light☒

Precipitation: None☒ Rain☐ Snow☐ Heavy☐ Moderate☐ Light☐ Sunny☒ Partly Cloudy☐

WELL MEASUREMENTS (Measurements in feet made from top of well casing) T = 350

Depth to Water N/M Total Depth 390 Feet of Water ~~N/M~~ Casing Diameter 16 inch Borehole Diameter 26 inch

Saturated Borehole Volume: 6200 gallons Three Saturated Well Volumes:_____gallons Well purged with: Dedicated Pump

INSTRUMENT CALIBRATION

pH Meter: Meter Number 14 - 59.0 - 5/10 **Conductivity Meter:** Meter Number 19

Buffer 7.00 Measured Value 7.00 Temp. 22.7 °C Standard 700 µS/cm Measured Value 702 µS/cm Temp. 22.9 °C

Buffer 10.02 Measured Value 10.02 Temp. 22.7 °C Standard 70 µS/cm Measured Value 723 µS/cm Temp 22.8 °C

Buffer 4.01 Measured Value 3.96 Temp 22.7 °C Standard_____µS/cm Measured Value_____µS/cm Temp._____°C

Turbidity Meter: Meter Number 31 **Eh Meter Number** 102

Standard 54 NTU Measured Value 54.1 NTU **Total Iron Meter Number** 30

Standard 6.45 NTU Measured Value 6.39 NTU **Ferrous Iron Meter Number** 30

Standard 58.1 NTU Measured Value 56.3 NTU **Dissolved Oxygen Meter Number** 30

Calibration Checks: EMF Zobell Solution 228 mV Temp 22.7 °C pH Buffer____ Measured Value_____ Temp_____°C

Cond. Standard_____µS/cm Measured Value_____µS/cm temp _____°C

Field Blank Samples: Fe Total Blank_____mg/L Fe^{2+}Blank_____mg/L Cond. Blank_____Temp_____°C

FIELD PARAMETER MEASUREMENTS DURING PURGING

Time	Volume (gallons)	pH	Cond. (µS/cm)	Temp. °C☐ °F☐	Turbidity Visual Est.☐ Measured☐	Comments
0900						pump on

FINAL SAMPLE PARAMETERS

Sample Date	Sample Time	Purge Volume	pH	EMF (mV)	Cond. (µS/cm)	Temp. (°C)	Turbidity (ntu)	Fe total (mg/L	Fe^{2+} (mg/L)	Diss. O_2 (mg/L)
5/26/00	0945*	157,500	9.14	141	978	20.0	0.20	0.01	0.01	3.8

Was a duplicate sample collected (02) Yes ☐ No ☒ (sample control number_____)

Was a field blank sample collected (03) Yes ☒ No ☐ (sample control number CW-04-03-000526)

Was a rinsate sample collected (04) Yes ☐ No ☒ (sample control number Water composited in bucket)

Other sample (_____) Yes ☐ No ☒ (sample control number_____)

Number of Sample Bottles Filled:

tes: Flow - Instant-meter Reading between 1300-1700 varies match 36.33 long gal

DI Column = pH = 2.94

* Bottle Time 9:45

pH air bubbling = 8.84 @ 22.5°C

no air bubbling = 9.13 @ 25.7°C

bubbled & sat but ≈ 3 hours

Sampler's Signature

GROUND WATER SAMPLING DATA SHEET

IDENTIFICATION Project Number: 100623

Sample Location City well 2 Date 5/23/00 Start Time 0910 Stop time 1300 Page 1 of 1

mple Control Number CW-02-01-000523 Samplers Tim Runnells

WEATHER CONDITIONS

Ambient Air Temperature: 76 °C☐ °F☒ Not Measured☒ **Wind:** Heavy☐ Moderate☐ Light☐

Precipitation: None☐ Rain☐ Snow☐ Heavy☐ Moderate☐ Light☐ Sunny☐ Partly Cloudy☐ Indoors

WELL MEASUREMENTS (Measurements in feet made from top of well casing) - unk - similar to well 4 - except 900'

Depth to Water NM Total Depth____ Feet of Water____ Casing Diameter ____ inch Borehole Diameter____ inch

Saturated Borehole Volume: ≈ 5/100 gallons Three Saturated Well Volumes:____ gallons Well purged with: Dedicated Pump

INSTRUMENT CALIBRATION

pH Meter: Meter Number 014 slope -59.6 **Conductivity Meter:** Meter Number 019

Buffer 10.02 Measured Value 10.02 Temp. 24.3 °C Standard 700 µS/cm Measured Value 700 µS/cm Temp 24.6 °C

Buffer 7.00 Measured Value 7.01 Temp. 24.3 °C Standard ~~69.9~~ µS/cm Measured Value____ µS/cm Temp.____ °C

Buffer 4.01 Measured Value 4.00 Temp 24.4 °C Standard 70 µS/cm Measured Value 69.9 µS/cm Temp 24.5 °C

Turbidity Meter: Meter Number 31 **Eh Meter Number** 102

Standard 58.1 NTU Measured Value 55.7 NTU **Total Iron Meter Number** 30

Standard 6.45 NTU Measured Value 6.39 NTU **Ferrous Iron Meter Number** 30

Standard 547 NTU Measured Value 542 NTU **Dissolved Oxygen Meter Number** 30

Calibration Checks: EMF Zobell Solution 225 mV Temp 24.0 °C pH Buffer____ Measured Value____ Temp____ °C

Cond. Standard____ µS/cm Measured Value____ µS/cm temp ____ °C

Field Blank Samples: Fe Total Blank____ mg/L Fe^{2+} Blank____ mg/L Cond. Blank____ Temp____ °C

FIELD PARAMETER MEASUREMENTS DURING PURGING

Time	Volume (gallons)	pH	Cond. (µS/cm)	Temp. °C☐ °F☐	Turbidity Visual Est.☐ Measured☐	Comments
0910						pump on - no H_2O level

FINAL SAMPLE PARAMETERS

Sample Date	Sample Time	Purge Volume	pH	EMF (mV)	Cond. (µS/cm)	Temp. (°C)	Turbidity (ntu)	Fe total (mg/L	Fe^{2+} (mg/L)	Diss. O_2 (mg/L)
5/23/00	10:10*	143,000	9.18	85	900	20.4	0.51	0.00	0.00	4.2

Was a duplicate sample collected (02) Yes ☐ No ☒ (sample control number____)

Was a field blank sample collected (03) Yes ☐ No ☒ (sample control number____)

Was a rinsate sample collected (04) Yes ☐ No ☒ (sample control number____)

Other sample (____) Yes ☐ No ☒ (sample control number____)

Number of Sample Bottles Filled:

Notes: Flow rate 50.35 sec / 1000 gal

* Bottles say 09:30 (Columns pH - 2.09 for flush

Air bubble sample ≈ 1.5 hrs " pH = 2.61 for Sample

pH = 6.93 @ 20.1°C

Sampler's Signature CS

1980

GROUND WATER SAMPLING DATA SHEET

IDENTIFICATION Project Number: 100623

Sample Location Fallon City Well 1 well #1 Date 5/24/00 Start Time 8:42 Stop time 1201 Page 1 of 1

nple Control Number NV-01-01-000524 Samplers Tim Rennells, Gary Evitt

..EATHER CONDITIONS

Ambient Air Temperature: 64 °C☐ °F☒ Not Measured ☐ **Wind:** Heavy☐ Moderate☐ Light☒

Precipitation: None☒ Rain☐ Snow☐ Heavy☐ Moderate☐ Light☐ Sunny☐ Partly Cloudy☒

WELL MEASUREMENTS (Measurements in feet made from top of well casing) 10", 16", 24" 30", 12"

Depth to Water NM Total Depth 540 Feet of Water 520 Casing Diameter ____ inch Borehole Diameter/ ~~[illegible]~~ inch

Saturated Borehole Volume: 26,100 gallons Three Saturated Well Volumes: ____ gallons Well purged with: Airlifted pump turbine

INSTRUMENT CALIBRATION

pH Meter: Meter Number 14 slope = 58.7 **Conductivity Meter:** Meter Number 19

Buffer 7.00 Measured Value 7.02 Temp. 23.1 °C Standard 700 µS/cm Measured Value 700 µS/cm Temp. 23.1 °C

Buffer 10.02 Measured Value 10.00 Temp. 23.1 °C Standard 70 µS/cm Measured Value 72.3 µS/cm Temp. 22.9 °C

Buffer 4.01 Measured Value 3.99 Temp. 22.7 °C Standard ____ µS/cm Measured Value ____ µS/cm Temp. ____ °C

Turbidity Meter: Meter Number 31 **Eh Meter Number** 102

Standard 947 NTU Measured Value 542 NTU **Total Iron Meter Number** 30 - DR-890

Standard 6.45 NTU Measured Value 6.35 NTU **Ferrous Iron Meter Number** 30 - "

Standard 59.1 NTU Measured Value 55.9 NTU **Dissolved Oxygen Meter Number** 30 - "

Calibration Checks: EMF Zobell Solution 230 mV Temp 21.7 °C pH Buffer ____ Measured Value ____ Temp ____ °C

Cond. Standard ____ µS/cm Measured Value ____ µS/cm temp ____ °C

Field Blank Samples: Fe Total Blank ____ mg/L Fe^{2+} Blank ____ mg/L Cond. Blank ____ Temp ____ °C

FIELD PARAMETER MEASUREMENTS DURING PURGING

Time	Volume (gallons)	pH	Cond. (µS/cm)	Temp. °C☐ °F☐	Turbidity Visual Est.☐ Measured☐	Comments
0845						pump on

FINAL SAMPLE PARAMETERS

Sample Date	Sample Time	Purge Volume	pH	EMF (mV)	Cond. (µS/cm)	Temp. (°C)	Turbidity (ntu)	Fe total (mg/L)	Fe^{2+} (mg/L)	Diss. O_2 (mg/L)
5/24/00	1000 ~~0945~~ TRR	44,750	9.19	-5 TRR ~~0.5~~	1091	20.9	0.27	0.03	0.00	6.5

Was a duplicate sample collected (02) Yes ☐ No ☒ (sample control number ____)

Was a field blank sample collected (03) Yes ☐ No ☒ (sample control number ____)

Was a rinsate sample collected (04) Yes ☐ No ☒ (sample control number ____)

Other sample (____) Yes ☐ No ☒ (sample control number ____)

Number of Sample Bottles Filled: ____

tes: Flow ~~[illegible]~~ 6.70 to ~~[illegible]~~ 7.70 / 100.42 sec, Electronic 1000 gal / 100.54 sec mech meter

pH after Air bubbling 2 hrs 5.75 @ 20.9°C

Sampler's Signature [signature]

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GROUND WATER SAMPLING DATA SHEET

IDENTIFICATION Project Number: 100623

Sample Location Fallon City - Naval well #3 Date 5/24/00 Start Time 1150 Stop time 1245 Page 1 of 1

Sample Control Number NW-03-01-000524 Samplers Tim Runnells, Gary Evett

WEATHER CONDITIONS

Ambient Air Temperature: 85 °C☐ °F☒ Not Measured ☐ **Wind:** Heavy☐ Moderate☒ Light☐

Precipitation: None☒ Rain☐ Snow☐ Heavy☐ Moderate☐ Light☐ Sunny☐ Partly Cloudy☒

WELL MEASUREMENTS (Measurements in feet made from top of well casing)

Depth to Water NM Total Depth 531 Feet of Water ≈510 Casing Diameter 24", 16" inch Borehole Diameter 30", 12" inch

Saturated Borehole Volume: ≈5,900 gallons Three Saturated Well Volumes: _____ gallons Well purged with: Dedicated Submersible Turbine

INSTRUMENT CALIBRATION – See NW-01 sheet

pH Meter: Meter Number 12 **Conductivity Meter:** Meter Number 19

Buffer____ Measured Value_____ Temp._____ °C Standard_____ µS/cm Measured Value_____ µS/cm Temp._____ °C

Buffer____ Measured Value_____ Temp._____ °C Standard_____ µS/cm Measured Value_____ µS/cm Temp._____ °C

Buffer____ Measured Value_____ Temp._____ °C Standard_____ µS/cm Measured Value_____ µS/cm Temp._____ °C

Turbidity Meter: Meter Number 31 **Eh Meter Number** 102

Standard _____NTU Measured Value_____NTU **Total Iron Meter Number** 30

Standard _____NTU Measured Value_____NTU **Ferrous Iron Meter Number** 30

Standard _____NTU Measured Value_____NTU **Dissolved Oxygen Meter Number** 30

Calibration Checks: EMF Zobell Solution _____mV Temp_____°C pH Buffer_____ Measured Value_____ Temp_____°C

Cond. Standard_____µS/cm Measured Value_____µS/cm temp _____°C

Field Blank Samples: Fe Total Blank_____mg/L Fe^{2+} Blank_____mg/L Cond. Blank_____Temp_____°C

FIELD PARAMETER MEASUREMENTS DURING PURGING

Time	Volume (gallons)	pH	Cond. (µS/cm)	Temp. °C☐ °F☐	Turbidity Visual Est.☐ Measured☐	Comments
1150						pump on

FINAL SAMPLE PARAMETERS

Sample Date	Sample Time	Purge Volume	pH	EMF (mV)	Cond. (µS/cm)	Temp. (°C)	Turbidity (ntu)	Fe total (mg/L	Fe^{2+} (mg/L)	Diss. O_2 (mg/L)
5/25/00	1245	92,900	9.10	25	1097	22.7	0.16	0.00	0.00	6.7

Was a duplicate sample collected (02) Yes ☐ No ☒ (sample control number_____)

Was a field blank sample collected (03) Yes ☐ No ☒ (sample control number_____)

Was a rinsate sample collected (04) Yes ☐ No ☒ (sample control number_____)

Other sample (_____) Yes ☐ No ☒ (sample control number_____)

Number of Sample Bottles Filled:_____

Notes: Column pH - 2.91, Flow 49.44 sec/1000 gal

pH after 2 hours w/ air bubbling 8.77 @ 20.9°C

Sampler's Signature _____

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GROUND WATER SAMPLING DATA SHEET

IDENTIFICATION Project Number: 100623

Sample Location Fallon City well #3 Date 5/25/00 Start Time 1300 Stop time 1330 Page 1 of 1

Sample Control Number CW-07-01-000525 Samplers Tim Runnells, Gary Evett

WEATHER CONDITIONS

Ambient Air Temperature: 85 °C☐ °F☒ Not Measured ☒ **Wind:** Heavy☐ Moderate☐ Light☒

Precipitation: None☒ Rain☐ Snow☐ Heavy☐ Moderate☐ Light☐ Sunny☒ Partly Cloudy☐ -

WELL MEASUREMENTS (Measurements in feet made from top of well casing) - unk - similar to well 4 - except 500'

Depth to Water NM Total Depth _____ Feet of Water _____ Casing Diameter _____ inch Borehole Diameter _____ inch

Saturated Borehole Volume: 29100 gallons Three Saturated Well Volumes: _____ gallons Well purged with: Dedicated Turbine

INSTRUMENT CALIBRATION

pH Meter: Meter Number 14

Buffer 7.00 Measured Value 7.01 Temp. 22.7 °C

Buffer 4.01 Measured Value 4.00 Temp. 22.9 °C

Buffer 10.07 Measured Value 10.04 Temp. 23.0 °C

Conductivity Meter: Meter Number 19

Standard 70 µS/cm Measured Value 76.5 µS/cm Temp. 22.1 °C

Standard 700 µS/cm Measured Value 701 µS/cm Temp. 22.6 °C

Standard _____ µS/cm Measured Value _____ µS/cm Temp. _____ °C

Turbidity Meter: Meter Number _____

Standard 58.1 NTU Measured Value 56.7 NTU

Standard 6.45 NTU Measured Value 6.47 NTU

Standard 547 NTU Measured Value 545 NTU

Eh Meter Number 102

Total Iron Meter Number 30

Ferrous Iron Meter Number 30

Dissolved Oxygen Meter Number 30

Calibration Checks: EMF Zobell Solution 231 mV Temp 22.9 °C pH Buffer _____ Measured Value _____ Temp _____ °C

Cond. Standard _____ µS/cm Measured Value _____ µS/cm temp _____ °C

Field Blank Samples: Fe Total Blank _____ mg/L Fe^{2+} Blank _____ mg/L Cond. Blank _____ Temp _____ °C

FIELD PARAMETER MEASUREMENTS DURING PURGING

Time	Volume (gallons)	pH	Cond. (µS/cm)	Temp. °C☐ °F☐	Turbidity Visual Est.☐ Measured☐	Comments
1100						Pump on

FINAL SAMPLE PARAMETERS

Sample Date	Sample Time	Purge Volume	pH	EMF (mV)	Cond. (µS/cm)	Temp. (°C)	Turbidity (ntu)	Fe total (mg/L	Fe^{2+} (mg/L)	Diss. O_2 (mg/L)
5/25/00	1330	165,000	9.15	111	925	20.5	0.23	0.03	0.02	6.0

Was a duplicate sample collected (02) Yes ☐ No ☒ (sample control number _____)

Was a field blank sample collected (03) Yes ☐ No ☒ (sample control number _____)

Was a rinsate sample collected (04) Yes ☐ No ☒ (sample control number _____)

Other sample (_____) Yes ☐ No ☒ (sample control number _____)

Number of Sample Bottles Filled: _____

Notes: ~~the~~ flow meter / column pH - 2.72

~ 54.10 gal / 1000 gal

Sampler's Signature _____

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~~[illegible]~~

GROUND WATER SAMPLING DATA SHEET

IDENTIFICATION Project Number: 100623

Sample Location: Fallon City well #2 Date: 5/25/00 Start Time: 0715 Stop time: 0945 Page 1 of 1

Sample Control Number: CW-01-01-000525 Samplers: Tim Renaud, Gary Evett

WEATHER CONDITIONS CW-01

Ambient Air Temperature: 63 °C☐ °F☒ Not Measured☒ **Wind:** Heavy☐ Moderate☐ Light☒

Precipitation: None☒ Rain☐ Snow☐ Heavy☐ Moderate☐ Light☐ Sunny☒ Partly Cloudy☐ Inside

WELL MEASUREMENTS (Measurements in feet made from top of well casing) – unk – similar to well 4 – except 500'

Depth to Water NM Total Depth _____ Feet of Water _____ Casing Diameter _____ inch Borehole Diameter _____ inch

Saturated Borehole Volume: ~~49.02~~ gallons Three Saturated Well Volumes: _____ gallons Well purged with: Dedicated turbine

INSTRUMENT CALIBRATION

pH Meter: Meter Number 14 – slope 59.7 **Conductivity Meter:** Meter Number 19

Buffer 7.00 Measured Value 7.01 Temp. 22.7 °C Standard 70 µS/cm Measured Value 70.5 µS/cm Temp. 22.1 °C

Buffer 4.01 Measured Value 4.00 Temp. 22.4 °C Standard 700 µS/cm Measured Value 701 µS/cm Temp. 22.6 °C

Buffer 10.02 Measured Value 10.04 Temp. 22.0 °C Standard _____ µS/cm Measured Value _____ µS/cm Temp. _____ °C

Turbidity Meter: Meter Number 31 **Eh Meter Number** 102

Standard 59.1 NTU Measured Value 56.7 NTU **Total Iron Meter Number** 30

Standard 6.45 NTU Measured Value 6.47 NTU **Ferrous Iron Meter Number** 30

Standard 545 NTU Measured Value 545 NTU **Dissolved Oxygen Meter Number** 30

Calibration Checks: EMF Zobell Solution 231 mV Temp 22.0 °C pH Buffer _____ Measured Value _____ Temp _____ °C

Cond. Standard _____ µS/cm Measured Value _____ µS/cm temp _____ °C

Field Blank Samples: Fe Total Blank _____ mg/L Fe^{2+} Blank _____ mg/L Cond. Blank _____ Temp _____ °C

FIELD PARAMETER MEASUREMENTS DURING PURGING

Time	Volume (gallons)	pH	Cond. (µS/cm)	Temp. °C☐ °F☐	Turbidity Visual Est.☐ Measured☐	Comments
0715						pump on

FINAL SAMPLE PARAMETERS

Sample Date	Sample Time	Purge Volume	pH	EMF (mV)	Cond. (µS/cm)	Temp. (°C)	Turbidity (ntu)	Fe total (mg/L	Fe^{2+} (mg/L)	Diss. O_2 (mg/L)
5/25/00	0945*	99,000	9.16	265	924	19.6	0.16	0.02	0.00	5.1

Was a duplicate sample collected (02) Yes ☒ No ☐ (sample control number CW-01-02-000525)

Was a field blank sample collected (03) Yes ☐ No ☒ (sample control number _____)

Was a rinsate sample collected (04) Yes ☐ No ☒ (sample control number _____)

Other sample (_____) Yes ☐ No ☒ (sample control number _____)

Number of Sample Bottles Filled: _____

Notes: * Bottles say 0915 Column pH = 2.67

pH air bubbling for 3 hours 9.90 @ 17.1°C

~~No flow meter~~ Asst City engineer says ≈ 1100 gpm for flow

TRR

Sampler's Signature _____

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APPENDIX C

CHAIN OF CUSTODY DOCUMENTATION

DRAFT

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Fallon

SMI Contact / Phone Number: Tim Rawlins 970-223-9600

Project Number: 100623

P.O. Number:

Delivery Method / Shipping Document Number: Hand Delivery

Send Results / Report To:
Tim Rawlins
Shepherd Miller Inc.
3801 Automation Way
Ft. Collins, CO 80525

Sampler (Print Name / Affiliation): Tim Rawlins/SMI, Gary Evett/Fallon

Signature: [illegible]

Analysis Requested: Total Coliform, Fecal Coliform, Nitrate, Nitrite, Ammonia, Total Phosphorus, Ortho Phosphorus, TDS, Metals, As, Cl, As Speciation

Preservative: HCl, HNO3, NaOH, H2SO4, HCl, HNO3, NaOH, HCl

Container Type and Size: 1 Liter Poly, 500 ml Poly, 250 ml Poly, 1 Liter Poly, 500 ml Poly, 250 ml Poly, 1 Liter Poly, 500 ml Poly, 250 ml Poly

Field Sample No./ Identification	Date	Time	Sample Matrix	Total No. of Cont.	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Remarks
CW-04-01-100526	5/26/06	8:46	GW	10		X	X			X		X	X		X		
CW-04-03-100526	5/26/06	10:36	GW	10		X	X			X		X	X		X		

Relinquished by: (Print Name/Affiliation)	Date:	Received by: (Print Name/Affiliation)	Date:	Analytical Laboratory (Destination):
Tim Rawlins/SMI Signature: [illegible]	5/26/06 Time: 14:00	Signature:	5/26/06 Time: 16:06	Sierra Environmental Monitoring 1135 Financial Blvd. Reno, NV 89502-2345
Relinquished by: (Print Name/Affiliation) Signature:	Date: Time:	Received by: (Print Name/Affiliation) Signature:	Date: Time:	
Relinquished by: (Print Name/Affiliation) Signature:	Date: Time:	Received for lab by: (Print Name) Signature:	Date: Time:	Condition/Temperature of Samples when Received:

Serial No.: No 3551

White: Return to SMI Yellow: Laboratory Pink: Field Team

Matrix Codes: SW = Surface Water GW = Ground Water S = Soil/Sediment ___ = _____

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Fallon

SMI Contact / Phone Number: Tim Rowells 970 223 7600

Project Number: 100623 P.O. Number:

Delivery Method / Shipping Document Number: Hand Delivery

Send Results / Report To: Tim Rowells, Shepherd Miller Inc., 3501 Automation Way, Ft. Collins, Co 80525

Sampler (Print Name / Affiliation): Tim Rowells/SMI, Gary Evett/UWCC

Signature:

Analysis Requested: Gross Alpha, Radium 226 & 228, Arsenic, Arsenic, Radon

Preservative: HNO3, HCl, HCl, HCl, HCl

Container Type and Size: 1 Liter Poly, 1 Liter Poly, 1 Liter Poly, 1 Liter Poly, 1 Liter Poly

Field Sample No./ Identification	Date	Time	Sample Matrix	Total No. of Cont.	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Remarks
CW-04-01-000626	4/26/00	8:45	GW	10		X	X		X			X		X			
CW-04-03-000426	4/26/00	10:30	GW	10		X	X		X			X					

Relinquished by: (Print Name/Affiliation)	Date:	Received by: (Print Name/Affiliation)	Date:	Analytical Laboratory (Destination):
Tim Rowells/SMI	4/26/00	Tim Rowells	4-26-00	Sierra Environmental Monitoring, 1135 Financial Blvd. Reno, NV 89502-2348
Signature:	Time: 1:07	Signature:	Time: 16:00	
Relinquished by: (Print Name/Affiliation)	Date:	Received by: (Print Name/Affiliation)	Date:	
Signature:	Time:	Signature:	Time:	
Relinquished by: (Print Name/Affiliation)	Date:	Received for lab by: (Print Name)	Date:	Condition/Temperature of Samples when Received:
Signature:	Time:	Signature:	Time:	

Serial No.: No 3552

White: Return to SMI Yellow: Laboratory Pink: Field Team

Matrix Codes: SW = Surface Water GW = Ground Water S = Soil/Sediment

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Fallon

SMI Contact / Phone Number: Tim Rennells [illegible]

Project Number: 100103 P.O. Number:

Delivery Method / Shipping Document Number: Hand Delivery

Send Results / Report To:
Tim Rennells
Shepherd Miller, Inc.
3801 Automation Way
Ft. Collins, CO 80525

Sampler (Print Name / Affiliation): Tim Rennells/SMI
Gary Fewell/[illegible]
Signature: [illegible]

Analysis Requested: Total Color, TSS, Silica, Alk, Cl, SO4, Alkalinity, NH3, Nitrite, TDS, NO3+NO2, metals, As, Cr, As speciation *

Preservative: Plastic HDPE, HDPE, HDPE,

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Fallon

SMI Contact / Phone Number: Tim Kunelis 970-223-9600

Project Number: 100623 P.O. Number:

Delivery Method / Shipping Document Number: Hand Delivery

Send Results / Report To: Tim Kunelis, Shepherd Miller, Inc., 3801 Automation Way, Ft. Collins, CO 80525

Sampler (Print Name / Affiliation): Tim Kunelis/SMI, Gary Everett/Fallon

Signature:

Analysis Requested: Alpha Beta, Gross Alpha, Radium 226, Radium 228, Arsenic, Arsenic, Arsenic, Radon

Preservative: Gallon Jug, HNO3; 1 Liter Plastic, HCl; 1 Liter Plastic, HCl; 40 ml Glass, HCl; 40 ml Glass, HCl; 40 ml Glass, 4°C

Container Type and Size

See Table 2 for all analytes

Field Sample No./ Identification	Date	Time	Sample Matrix	Total No. of Cont.	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Remarks
CW-01-01-000525	4/26/00	8:15	GW	12		X	X		X			X		X			Laboratory Replicate
CW-01-02-000525	4/26/00	8:15	GW	12		X	X		X			X		X			
CW-03-01-000525	5/25/00	1330	GW	12		X	X		X			X		X			
CW-04-01-000525	5/25/00	1520	GW	2										X			

Relinquished by: (Print Name/Affiliation)	Date:	Received by: (Print Name/Affiliation)	Date:	Analytical Laboratory (Destination):
Tim Kunelis/SMI Signature: Time: 1700	5/25/00	Jamie Ward Signature: Time: 1700	5/25/00	Severn Environmental Monitoring 455 Fairchild Blvd. Raleigh 27603-3345
Relinquished by: (Print Name/Affiliation) Signature:	Date: Time:	Received by: (Print Name/Affiliation) Signature:	Date: Time:	
Relinquished by: (Print Name/Affiliation) Signature:	Date: Time:	Received for lab by: (Print Name) Signature:	Date: Time:	Condition/Temperature of Samples when Received:

Serial No.: 3558

White: Return to SMI Yellow: Laboratory Pink: Field Team

Matrix Codes: SW = Surface Water GW = Ground Water S = Soil/Sediment ___ = _____

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Dallas

SMI Contact / Phone Number: Tim Rowells

Project Number: 100623 P.O. Number:

Delivery Method / Shipping Document Number: Hand Delivery

Send Results / Report To:
Tim Rowells
Shepherd Miller, Inc.
3801 Automation Way
Ft. Collins, CO 80525

Sampler (Print Name / Affiliation): Tim Rowells/SMI

Signature:

Analysis Requested: Total Metals, Total Arsenic, Interpretive, TDS, NO3+NO2, Metals, As LR, As Speciated

Preservative: HDPE 1PL, HDPE 4PL, Poly 1L, HDPE 1L, HDPE 1L, HDPE

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Page 1 of 2

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Fallon

SMI Contact / Phone Number: Tim Rarrells 970-223-9600

Project Number: 100623

P.O. Number:

Delivery Method / Shipping Document Number: Hand Delivery

Send Results / Report To:
Tim Rarrells
Shepherd Miller Inc.
3801 Automation Way
Ft. Collins, CO 80525

Sampler (Print Name / Affiliation): Tim Rarrells/SMI

Signature:

Analysis Requested

Field Sample No./ Identification	Date	Time	Sample Matrix	Total No. of Cont.	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Remarks
CW-02-01-000-23	5/8/02	0950	GW	12		X	V		V			V		V			matrix spike

Preservative: Total Cl2 / HNO3 / HCl / HCl / HCl / 4°C / 4°C

Container Type and Size: 1 Liter Amber / 1 Liter Amber / 1 Liter Amber /

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Page 1 of 2

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Fallon

SMI Contact / Phone Number: Tim Rowells

Project Number: 100623 P.O. Number:

Delivery Method / Shipping Document Number: Hand Delivered

Send Results / Report To: Tim Rowells, Shepherd Miller Inc., 3801 Automation Way, Ft Collins, CO 80525

Sampler (Print Name / Affiliation): Tim Rowells/SMI, Gary Webb/SMI

Signature:

Analysis Requested: Volatile Organics 8260B, All Cations/Anions, TDS, NO3+NO2, Metals, As, Cr, As speciation

Preservative: HCl, HCl, HCl, HNO3, HNO3, HCl

Container Type and Size: 40ml VOA, 500ml HDPE, 500ml HDPE, 500ml HDPE, 500ml HDPE, 500ml HDPE

See Table 1 for all analytes

Field Sample No./ Identification	Date	Time	Sample Matrix	Total No. of Cont.	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Remarks
NW-01-01-000624	5/24/00	1000	GW	12		X	X			X		X	X		X		
NW-03-01-000624	5/24/00	1245	GW	12		X	X			X		X	X		X		

Relinquished by: (Print Name/Affiliation)	Date:	Received by: (Print Name/Affiliation)	Date:	Analytical Laboratory (Destination):
Tim Rowells/SMI Signature: Time: 1630	5/26/00	Jason Rod SMI Signature: Time: 1630	5/26/00	Sierra Environmental Monitoring 1135 Financial Blvd. Reno, NV 89502-2345
Relinquished by: (Print Name/Affiliation) Signature:	Date: Time:	Received by: (Print Name/Affiliation) Signature:	Date: Time:	
Relinquished by: (Print Name/Affiliation) Signature:	Date: Time:	Received for lab by: (Print Name) Signature:	Date: Time:	Condition/Temperature of Samples when Received:

Serial No.: 3553

White: Return to SMI Yellow: Laboratory Pink: Field Team

Matrix Codes: SW = Surface Water GW = Ground Water S = Soil/Sediment ___ = _____

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Page 1 of 2

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Fallon

SMI Contact / Phone Number: Tim Rowells 970-223-9600

Project Number: 100603 P.O. Number:

Delivery Method / Shipping Document Number: Hand Delivery

Send Results / Report To: Tim Rowells, Shepherd Miller Inc., 3801 Automation Way, Ft. Collins, CO 80525

Sampler (Print Name / Affiliation): Tim Rowells

Signature:

Analysis Requested: Total Silver, As, Total Cyanide, Cyanide Amenable, TDS, Nitrate, Nitrite, Metals, Asbestos

Preservative: 4C, 4C, H2SO4, HNO3, HNO3

Container Type and Size: 1 liter Poly, 1 liter Poly, 1 liter Poly, 1 liter Poly, 1 liter Poly

See Table 1 for all analytes

Field Sample No./ Identification	Date	Time	Sample Matrix	Total No. of Cont.	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Remarks
CW-02-01-000503	5/5/03	0910	GW	12			Y				Y		Y				Matrix spike

Relinquished by: (Print Name/Affiliation) Tim Rowells — Date: 5/5/03 — Time: 1551

Received by: (Print Name/Affiliation) [illegible] — Date: 5/5/03 — Time: 1551

Analytical Laboratory (Destination): AAL Analytical Lab, 1500 Glendale Ave., Reno, NV 89510

Relinquished by: (Print Name/Affiliation) — Date: — Time:

Received by: (Print Name/Affiliation) — Date: — Time:

Relinquished by: (Print Name/Affiliation) — Date: — Time:

Received for lab by: (Print Name) — Date: — Time:

Condition/Temperature of Samples when Received:

Serial No.: 3545

White: Return to SMI Yellow: Laboratory Pink: Field Team

Matrix Codes: SW = Surface Water GW = Ground Water S = Soil/Sediment ___ = _____

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Page 1 of 1

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: Citrus Tallow

SMI Contact / Phone Number: Tim Rowells 970-223-9600

Project Number: 100603 P.O. Number:

Delivery Method / Shipping Document Number: Hand Delivery

Send Results / Report To: Tim Rowells, Shepherd Miller Inc., 3801 Automation Way, Ft. Collins, CO 80525

Sampler (Print Name / Affiliation): Tim Rowells / SMI

Signature:

Analysis Requested: Gross Alpha, Radium 226 & 228, Arsenic, Arsenic, Radon

Preservative: HNO3, HCl, HCl, HCl, HCl

Container Type and Size: 1 L HDPE, 1 L HDPE, 1 L HDPE, 1 L HDPE, 1 L HDPE

See Tallow for all analyses

Field Sample No./ Identification	Date	Time	Sample Matrix	Total No. of Cont.	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Remarks
CW-02 01-000523	1/23/00	0930	GW	12		Y	Y		Y			Y		X			Matrix spike

Relinquished by: (Print Name/Affiliation)	Date	Received by: (Print Name/Affiliation)	Date	Analytical Laboratory (Destination):
Tim Rowells / SMI Signature:	1/23/00 Time: 1351	Kris Allen Signature:	1/23/00 Time: 1351	AAL Laboratory 1500 Glendale Ave. Reno, NV 89510
Relinquished by: (Print Name/Affiliation) Signature:	Date: Time:	Received by: (Print Name/Affiliation) Signature:	Date: Time:	
Relinquished by: (Print Name/Affiliation) Signature:	Date: Time:	Received for lab by: (Print Name) Signature:	Date: Time:	Condition/Temperature of Samples when Received:

Serial No.: No. 3546

White: Return to SMI Yellow: Laboratory Pink: Field Team

Matrix Codes: SW = Surface Water GW = Ground Water S = Soil/Sediment ___ = _____

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Telluride

SMI Contact / Phone Number: [illegible]

Project Number: 100023 P.O. Number:

Delivery Method / Shipping Document Number: Hand Deliver

Send Results / Report To: Tim Rennills, Shepherd Miller Inc, 3801 Automation Way, Ft. Collins, CO 80525

Sampler (Print Name / Affiliation): Tim Rennills/SMI, Gary Eve#/[illegible]

Signature: [illegible]

Analysis Requested: TDS, NO3 NO2, Metals, Ac, CF

Preservative: See Table 1 for all analyses

Container Type and Size

Field Sample No./ Identification	Date	Time	Sample Matrix	Total No. of Cont.	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Remarks
GW-01-01-000525	[illegible]	11:15	GW	12		X	X			X		X	X				Laboratory Replicate
GW-01-02-000529	[illegible]	11:15	GW	12		X	X			X		X	X				Laboratory Replicate
GW-03-01-000525	[illegible]	13:00	GW	12		X	X			X		X	X				
GW-04-01-000525	[illegible]	15:00	GW	2													

Relinquished by: (Print Name/Affiliation)	Date:	Received by: (Print Name/Affiliation)	Date:	Analytical Laboratory (Destination):
Tim Rennills/SMI Signature: [illegible]	Time: [illegible]	Signature: [illegible]	Time: [illegible]	AAL Laboratories 1500 Glendale Ave. Reno, NV 89510
Relinquished by: (Print Name/Affiliation) Signature:	Date: Time:	Received by: (Print Name/Affiliation) Signature:	Date: Time:	
Relinquished by: (Print Name/Affiliation) Signature:	Date: Time:	Received for lab by: (Print Name) Signature:	Date: Time:	Condition/Temperature of Samples when Received:

Serial No.: No 3505

White: Return to SMI Yellow: Laboratory Pink: Field Team

Matrix Codes: SW = Surface Water GW = Ground Water S = Soil/Sediment

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Page 2

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Fallon

SMI Contact / Phone Number: Tim Rowells 970-223-9600

Project Number: 60623 P.O. Number:

Delivery Method / Shipping Document Number: Hand Delivery

Send Results / Report To:
Tim Rowells
Shepherd Miller Inc.
3801 Automation Way
Ft. Collins, CO 80525

Sampler (Print Name / Affiliation): Tim Rowells/SMI, Gary Evett/WRLC
Signature:

Analysis Requested: Gross Alpha, Radium 226 & 228, Arsenic, Arsenic, Radon

Preservative: 1N HNO3, HCl, HCl, 4°C, 4°C

Container Type and Size: 1L Poly, 1L Poly, 1L Poly,

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Page 2

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Fallon

SMI Contact / Phone Number: Tim Russells 970-223-9600

Project Number: 100623 P.O. Number:

Delivery Method / Shipping Document Number: Hand Delivery

Send Results / Report To: Tim Russells, Shepherd Miller Inc., 3801 Automation Way, Ft. Collins, CO 80525

Sampler (Print Name / Affiliation): Tim Russells / Gary Evenhouse

Signature:

Analysis Requested: Total Metals, Cations, Anions, Nitrate, Nitrite, TDS, NO3 + NO2, Metals, As, Cr

Preservative: HNO3 HNO3 HNO3 HNO3 HNO3 HNO3 HNO3 HNO3 HNO3 HNO3 HNO3 HNO3 HNO3 HNO3 HNO3 HNO3 HNO3 HNO3 HNO3 HNO3 HNO3 HNO3 HNO3 HNO3

Container Type and Size: See Table 1 for all matrices

Field Sample No / Identification	Date	Time	Sample Matrix	Total No. of Cont.	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Remarks
MW-01-01-000524	5/24/00	1000	GW	12		/	X			X		X	X				
MW-03-01-000524	5/24/00	1215	GW	12		X	X			X		X	X				

Relinquished by: (Print Name/Affiliation)	Date:	Received by: (Print Name/Affiliation)	Date:	Analytical Laboratory (Destination):
Tim Russell / Hilland Signature: Time: 1:20	5/24/00	Kim McCoy Signature:	5/25/00 Time: 11:20	All Environmental 1500 Glendale Ave. Reno, NV 89510
Relinquished by: (Print Name/Affiliation) Signature:	Date: Time:	Received by: (Print Name/Affiliation) Signature:	Date: Time:	
Relinquished by: (Print Name/Affiliation) Signature:	Date: Time:	Received for lab by: (Print Name) Signature:	Date: Time:	Condition/Temperature of Samples when Received:

Serial No.: No 3549

White: Return to SMI Yellow: Laboratory Pink: Field Team

Matrix Codes: SW = Surface Water GW = Ground Water S = Soil/Sediment ___ = _____

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Page 1 of 2

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Fallon

SMI Contact / Phone Number: Tim Russells 970-223-9600

Project Number: 100623 P.O. Number:

Delivery Method / Shipping Document Number: Hand Delivered

Send Results / Report To: Tim Russells, Shepherd Miller Inc, 3801 Automation Way, Ft Collins, CO 80525

Sampler (Print Name / Affiliation): Tim Russells / SMI, Gary Evans / Fallon

Signature:

Analysis Requested: Gross Alpha, Radium 226, Radium 228, Arsenic, Arsenic, Arsenic, Radon

Preservative: HNO3, HCl, HCl, HCl, HCl

Container Type and Size: 1 Gal Poly, 1 Gal Poly, 1 Gal Poly,

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Pag 1 2

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Dallas

SMI Contact / Phone Number: Tim Rowells 970 223 9600

Project Number: 100653

P.O. Number:

Delivery Method / Shipping Document Number: Hand Delivery

Send Results / Report To: Tim Rowells, Shepherd Miller Inc., 3801 Automation Way, Ft. Collins, CO 80525

Sampler (Print Name / Affiliation): Tim Rowells/SMI, Greg Everett/LWCC

Signature:

Analysis Requested: TDS, Hard Mg, Mg/Ca, Na, K, Cl

Preservative: H01, H02, H02, H03, H02, H02

Container Type and Size: 1L Poly, 1L Poly, 1L Poly, 1L Poly, 1L Poly, 1L Poly

Field Sample No./ Identification	Date	Time	Sample Matrix	Total No. of Cont.	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Remarks
CW-04-01-000626	4/26/00	3:45	GW	10		X	X			X		X	X				
CW-04-03-000526	4/26/00	10:20	GW	10		X	X			X		X	X				

Relinquished by: (Print Name/Affiliation)	Date:	Received by: (Print Name/Affiliation)	Date:	Analytical Laboratory (Destination):
Tim Rowells/SMI Signature:	4/26/00 Time: 1700	Eric McCoy Signature:	5/2/00 Time: 1530	AZ Laboratories 1660 Oak Park Ave. N. Oakland 94510
Relinquished by: (Print Name/Affiliation) Signature:	Date: Time:	Received by: (Print Name/Affiliation) Signature:	Date: Time:	
Relinquished by: (Print Name/Affiliation) Signature:	Date: Time:	Received for lab by: (Print Name) Signature:	Date: Time:	Condition/Temperature of Samples when Received:

Serial No.: No 3606

White: Return to SMI Yellow: Laboratory Pink: Field Team

Matrix Codes: SW = Surface Water GW = Ground Water S = Soil/Sediment ___ = _____

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Yellow

SMI Contact / Phone Number: Tim Rowells 970-223-9600

Project Number: 100603 P.O. Number:

Delivery Method / Shipping Document Number: Hand Delivery

Send Results / Report To:
Tim Rowells
Shepherd Miller, Inc.
3801 Automation Way
Ft. Collins, Co 80525

Sampler (Print Name / Affiliation): Tim Rowells/SMI
Gary Eyett/WWC
Signature:

Analysis Requested: Gross Alpha Beta Radium 226 / Arsenic / Arsenic / Arsenic / Radon

Preservative: HNO3 / HCl / HCl / 4°C / 4°C

Container Type and Size: 1 liter plastic / 1 liter plastic / 1 liter plastic / 1 liter plastic / 1 liter plastic / 1 liter plastic

Field Sample No./ Identification	Date	Time	Sample Matrix	Total No. of Cont.	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Remarks
CW-04-01-W05226	5/24/00	8:45	GW	10			X	X		X			X		X		
CW-04-03-W05226	5/24/00	10:30	GW	10			X	X		X			X				

Relinquished by: (Print Name/Affiliation)	Date:	Received by: (Print Name/Affiliation)	Date:	Analytical Laboratory (Destination):
Tim Rowells/SMI Signature: Time: 1530	5/26/00	Ron Allen/AAL Signature: Time: 1530	5/26/00	AAL Environmental 1500 Glendale Ave. Reno, NV 89510
Relinquished by: (Print Name/Affiliation) Signature:	Date: Time:	Received by: (Print Name/Affiliation) Signature:	Date: Time:	
Relinquished by: (Print Name/Affiliation) Signature:	Date: Time:	Received for lab by: (Print Name) Signature:	Date: Time:	Condition/Temperature of Samples when Received: Serial No.: No 3602

White: Return to SMI Yellow: Laboratory Pink: Field Team

Matrix Codes: SW = Surface Water GW = Ground Water S = Soil/Sediment ___ = _____

578

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Fallon

SMI Contact / Phone Number: Tim Russells 970-223-9600

Project Number: 100623

P.O. Number:

Delivery Method / Shipping Document Number: Fed-EX

Send Results / Report To:
Tim Russells
Shepherd Miller Inc
3801 Automation Way
Ft. Collins, CO 80525

Sampler (Print Name / Affiliation): Tim Russells/SMI
Gary Kuest / WWC

Signature:

Analysis Requested: TDS, NO3 + NO2, Metals, Hg, HCY, As speciated

Preservative: 4°C, HNO3, HCl

Container Type and Size: See Table 1 for all containers

Field Sample No./ Identification	Date	Time	Sample Matrix	Total No. of Cont.	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Remarks
GW-01-01-000525	5/24/10	8:15	GW	~~4~~ 10													Laboratory Replicate
GW-01-02-000525	5/24/10	8:15	GW	~~4~~ 10		X	X			X		X	X		X		~~Laboratory Replicate~~

Relinquished by: (Print Name/Affiliation)	Date:	Received by: (Print Name/Affiliation)	Date:	Analytical Laboratory (Destination):
Tim Russells/SMI				SWL
Signature:	Time:	Signature:	Time:	845 Government Gulch
Relinquished by: (Print Name/Affiliation)	Date:	Received by: (Print Name/Affiliation)	Date:	Hailey, ID 83333
Signature:	Time:	Signature:	Time:	
Relinquished by: (Print Name/Affiliation)	Date:	Received for lab by: (Print Name)	Date:	Condition/Temperature of Samples when Received:
Signature:	Time:	Signature:	Time:	

Serial No.: 3599

White: Return to SMI Yellow: Laboratory Pink: Field Team

Matrix Codes: SW = Surface Water GW = Ground Water S = Soil/Sediment ___ = _____

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Page 1 of 2

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Fallon

SMI Contact / Phone Number: Tim Rowells 970-223-9600

Project Number: 100623

P.O. Number:

Delivery Method / Shipping Document Number: Fed Ex

Send Results / Report To:
Tim Rowells
Shepherd Miller, Inc.
3801 Automation Way
Ft. Collins, Co 80525

Sampler (Print Name / Affiliation): Tim Rowells/SMI, Gary Evett/WNC

Signature:

Analysis Requested: Gross Alpha Beta, Radium 226, Arsenic, Arsenic, Arsenic, Radon

Preservative: HNO3, HCl, HCl, HCl, HCl, HCl

Container Type and Size: 1 Liter Poly, 1 Liter Poly, 1 Liter Poly, 1 Liter Poly, 1 Liter Poly, 1 Liter Poly

See Table 1 for all analytes

Field Sample No./ Identification	Date	Time	Sample Matrix	Total No. of Cont.	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Remarks
CW-01-01-000525	8-15	600	GW	5/4													Laboratory Replicate
CW-01-02-000525	8-15	600	GW	5/4													~~Laboratory Replicate~~ TKR

Relinquished by: (Print Name/Affiliation)	Date: / Time:	Received by: (Print Name/Affiliation)	Date: / Time:	Analytical Laboratory (Destination):
Tim Rowells/SMI Signature:		Signature:		SVL One Government Gulch Kellogg, ID 83837
Relinquished by: (Print Name/Affiliation) Signature:	Date: / Time:	Received by: (Print Name/Affiliation) Signature:	Date: / Time:	
Relinquished by: (Print Name/Affiliation) Signature:	Date: / Time:	Received for lab by: (Print Name) Signature:	Date: / Time:	Condition/Temperature of Samples when Received:

Serial No.: № 3600

White: Return to SMI Yellow: Laboratory Pink: Field Team

Matrix Codes: SW = Surface Water GW = Ground Water S = Soil/Sediment

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Page 1 of 2

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Fallon

SMI Contact / Phone Number: Tim Purcells 970-223-9600

Project Number: 100623 P.O. Number:

Delivery Method / Shipping Document Number: Fed-Ex

Send Results / Report To: Tim Purcells, Shepherd Miller, Inc., 3501 Automation Way, Ft. Collins, CO 80525

Sampler (Print Name / Affiliation): Tim Purcells/SMI, Gary Eve#1/UNKC

Signature: [illegible]

Analysis Requested: TDS, NO3 + NO2, Metals, Hg, Cr, As, specified by Table 1 for all analytes

Preservative: HCl, HCl, HNO3, HCl

Container Type and Size: 1 liter poly

Field Sample No./ Identification	Date	Time	Sample Matrix	Total No. of Cont.	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Remarks
CW-03-01-000525	4/25/00	1330	GW	4			X			X		X	X		X		

Reinquished by: (Print Name/Affiliation): Tim Purcells/SMI
Signature: [illegible] Date: 4/25/00 Time: 1400

Received by: (Print Name/Affiliation) Signature: Date: Time:

Reinquished by: (Print Name/Affiliation) Signature: Date: Time:

Received by: (Print Name/Affiliation) Signature: Date: Time:

Reinquished by: (Print Name/Affiliation) Signature: Date: Time:

Received for lab by: (Print Name) Signature: Date: Time:

Analytical Laboratory (Destination): SVL, Oro Grande Government Gulch, Kellogg, ID 83837

Condition/Temperature of Samples when Received:

Serial No.: No 3597

White: Return to SMI Yellow: Laboratory Pink: Field Team

Matrix Codes: SW = Surface Water GW = Ground Water S = Soil/Sediment

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Fallon

SMI Contact / Phone Number: Tim Rawlins 970-223-9600

Project Number: 100623 P.O. Number:

Delivery Method / Shipping Document Number: Fed Ex

Send Results / Report To: Tim Rawlins, Shepherd Miller, Inc., 3801 Automation Way, Ft. Collins, CO 80525

Sampler (Print Name / Affiliation): Tim Rawlins/SMI, Cory Ewert/Burns

Signature: [illegible]

Analysis Requested: Gross Alpha, Radium 226 & 228, Arsenic, Arsenic, Arsenic, Radon

Preservative: HCl, HCl, HCl, HCl, HCl, HCl

Container Type and Size: 1 liter poly, 1 liter poly, 1 liter poly, 1 liter poly, 1 liter poly, 1 liter poly

See Table 1 for all analytes

Field Sample No./ Identification	Date	Time	Sample Matrix	Total No. of Cont.	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Remarks
CW-03-01-000526	7/24/01	1330	GW	6		X	X		X			X		X	X		

Relinquished by: (Print Name/Affiliation): Tim Rawlins / SMI
Signature: [illegible] Date: 7/24/01 Time: [illegible]

Received by: (Print Name/Affiliation) Date: Time: Signature:

Relinquished by: (Print Name/Affiliation) Date: Time: Signature:

Received by: (Print Name/Affiliation) Date: Time: Signature:

Relinquished by: (Print Name/Affiliation) Date: Time: Signature:

Received for lab by: (Print Name) Date: Time: Signature:

Analytical Laboratory (Destination): SVL
[illegible] Government Gulch
Idaho Falls, ID 83537

Condition/Temperature of Samples when Received:

Serial No.: No 3598

White: Return to SMI Yellow: Laboratory Pink: Field Team

Matrix Codes: SW = Surface Water GW = Ground Water S = Soil/Sediment ___ = ___

582

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Fallon

SMI Contact / Phone Number: Tim Russells

Project Number: 100623 P.O. Number:

Delivery Method / Shipping Document Number: Fed-Ex

Send Results / Report To:
Tim Russells
Shepherd Miller, Inc.
3801 Automation Way
Ft. Collins, CO 80525

Sampler (Print Name / Affiliation): Tim Russells/SMI
Gary Everett/WRC

Signature:

Analysis Requested: See Table 1 for all analytes

Preservative: HNO3, HNO3, HCl, HCl, HCl, HCl, HCl

Container Type and Size: Poly, Poly, Poly, Poly, Poly, Poly, Poly

Field Sample No./ Identification	Date	Time	Sample Matrix	Total No. of Cont.	Filt. Y N	Filt. Y N	Filt. Y N	Filt. Y N	Filt. Y N	Filt. Y N	Remarks
					Y	Y	Y	Y	Y	Y	Call chris
CW-01-01-000525	5/24/00	8:15	GW	7					X		prior
CW-01-02-000525	5/24/00	8:15	GW	2					X		
CW-03-01-000525	5/24/00	1330	GW	2					X		Accutabs Inc. - Roland Kinney
CW-04-01-000525	5/24/00	1530	GW	2					X		4663 Table Mountain Drive
											Golden, CO 80403-1650
											303/277-9514

Relinquished by: (Print Name/Affiliation)	Date:	Received by: (Print Name/Affiliation)	Date:	Analytical Laboratory (Destination):
Tim Russells	5/25/00	Accutabs	5/25/00	From Tim Russells VIA SVL
Signature:	Time: 17:14	Signature: M. Kramer	Time: 1718	
Relinquished by: (Print Name/Affiliation)	Date:	Received by: (Print Name/Affiliation)	Date:	
Signature:	Time:	Signature:	Time:	
Relinquished by: (Print Name/Affiliation)	Date:	Received for lab by: (Print Name)	Date:	Condition/Temperature of Samples when Received:
Signature:	Time:	Signature:	Time:	

Serial No.: № 3558

White: Return to SMI Yellow: Laboratory Pink: Field Team

Matrix Codes: SW = Surface Water GW = Ground Water S = Soil/Sediment

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Page 1 of 2

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Fallon

SMI Contact / Phone Number: Tim Russell 970-223-9600

Project Number: 100603 P.O. Number:

Delivery Method / Shipping Document Number: Fed-Ex

Send Results / Report To: Tim Russell, Shepherd Miller, Inc., 3801 Automation Way, Ft. Collins, CO 80525

Sampler (Print Name / Affiliation): Tim Russell/SMI, Gary Everett/WNC

Signature:

Analysis Requested: Total Coliform, Fecal Coliform, Arsenic, TDS, NO2/NO3, Metals, As, Cr, As Speciation — See Table 1 for all analytes

Preservative: HDPE 500 ml 4°C; HDPE 500 ml 4°C; HDPE 500 ml H_2SO_4; HDPE 500 ml HNO_3; HDPE 500 ml HNO_3; HDPE 500 ml HCl

Container Type and Size

Field Sample No./ Identification	Date	Time	Sample Matrix	Total No. of Cont.	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Remarks
NW-01-01-000524	7/24/00	1000	GW	12			N	N					N		N		
NW-03-01-000624	7/24/00	1245	GW	12		X	X			X		X	X		X		

Relinquished by: (Print Name/Affiliation): Tim Russell/SMI
Signature:
Date: 7/24/00
Time: 5:45

Received by: (Print Name/Affiliation)
Signature:
Date:
Time:

Analytical Laboratory (Destination): SUL, One Government Gulch, Alleggin D 59337

Relinquished by: (Print Name/Affiliation)
Signature:
Date:
Time:

Received by: (Print Name/Affiliation)
Signature:
Date:
Time:

Relinquished by: (Print Name/Affiliation)
Signature:
Date:
Time:

Received for lab by: (Print Name)
Signature:
Date:
Time:

Condition/Temperature of Samples when Received:

Serial No.: No 3595

White: Return to SMI Yellow: Laboratory Pink: Field Team

Matrix Codes: SW = Surface Water GW = Ground Water S = Soil/Sediment ___ = _____

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Idaho

SMI Contact / Phone Number: Tim Rowells

Project Number: 100623 P.O. Number:

Delivery Method / Shipping Document Number: Fed-Ex

Send Results / Report To: Tim Rowells, Shepherd Miller, Inc., 3801 Automation Way, Ft. Collins, CO 80525

Sampler (Print Name / Affiliation): Tim Rowells/SMI, Gary Eastwake

Signature:

Analysis Requested: Gross Alpha Beta, Ra 226 & Ra 228, As, As, As, Radon

Preservative: HNO3, HNO3, HCl, HCl, HCl, HCl

Container Type and Size: 1 Liter Poly, 1 Liter Poly, 1 Liter Poly, 1 Liter Poly, 1 Liter Poly, 1 Liter Poly

Field Sample No./ Identification	Date	Time	Sample Matrix	Total No. of Cont.	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Remarks
NW-01-01 100634	5/24/00	1000	GW	12		Y	X		X			X		X			
NW-03-01-100534	5/24/00	1245	GW	12		Y	X		X			X		X			

Relinquished by: (Print Name/Affiliation)	Date:	Received by: (Print Name/Affiliation)	Date:	Analytical Laboratory (Destination):
Tim Rowells/SMI	5/24/00			SVL
Signature:	Time: 1245	Signature:	Time:	342 Government Gulch
Relinquished by: (Print Name/Affiliation)	Date:	Received by: (Print Name/Affiliation)	Date:	Kellogg, ID 83837
Signature:	Time:	Signature:	Time:	
Relinquished by: (Print Name/Affiliation)	Date:	Received for lab by: (Print Name)	Date:	Condition/Temperature of Samples when Received:
Signature:	Time:	Signature:	Time:	

Serial No.: No 3596

White: Return to SMI Yellow: Laboratory Pink: Field Team

Matrix Codes: SW = Surface Water GW = Ground Water S = Soil/Sediment ___ = _____

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Fallon

SMI Contact / Phone Number: Tim Rossellis [illegible]

Project Number: 100623

P.O. Number:

Delivery Method / Shipping Document Number: Fed Ex

Send Results / Report To:
Tim Rossellis
Shepherd Miller Inc
3801 Automation Way
Ft. Collins, CO 80525

Sampler (Print Name / Affiliation): Tim Rossellis/SMI

Signature:

Analysis Requested: Temperature, Sulfate, Alkalinity, Chloride, TDS, NO3 NO2, Metals, As, Cr, Hg, Se, Total Recall analysis

Preservative: HNO3 / HNO3 / HNO3 /

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Fallon

SMI Contact / Phone Number: Tim Russells 970 223-9600

Project Number: 100623 P.O. Number:

Delivery Method / Shipping Document Number: Fed Ex

Send Results / Report To: Tim Russells, Shepherd Miller Inc., 3501 Automation Way, Ft. Collins, CO 80525

Sampler (Print Name / Affiliation): Tim Russells/SMI

Signature:

Analysis Requested: Gross Alpha Beta-1 (40 CFR Radium); Arsenic; Arsenic; Radiol

Preservative: HNO3; HCl; HCl; HNO3; HNO3; 4°C; 4°C; 4°C; 4°C

Container Type and Size: See Table 1 for all analyses

Field Sample No./ Identification	Date	Time	Sample Matrix	Total No. of Cont.	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Remarks
EW-02-01-000523	5/23/00	0930	GW	12		X	X		X			X		X			Matrix spike

Relinquished by: (Print Name/Affiliation): Tim Russells/SMI
Signature:
Date: 5/23/00
Time: 1600

Received by: (Print Name/Affiliation)
Signature:
Date:
Time:

Analytical Laboratory (Destination): DVL, one Government Gulch, Helena, MT 59623

Relinquished by: (Print Name/Affiliation)
Signature:
Date:
Time:

Received by: (Print Name/Affiliation)
Signature:
Date:
Time:

Relinquished by: (Print Name/Affiliation)
Signature:
Date:
Time:

Received for lab by: (Print Name)
Signature:
Date:
Time:

Condition/Temperature of Samples when Received:

Serial No.: No 3569

White: Return to SMI Yellow: Laboratory Pink: Field Team

Matrix Codes: SW = Surface Water GW = Ground Water S = Soil/Sediment

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Fallon

SMI Contact / Phone Number: Tim Rusnells 970-223-9600

Project Number: 100623 P.O. Number:

Delivery Method / Shipping Document Number: Fed Ex

Send Results / Report To:
Tim Rusnells
Shepherd Miller Inc.
3801 Automation Way
Ft. Collins, CO 80525

Sampler (Print Name / Affiliation): Tim Rusnells/SMI
Gary Ewett
Signature: [signature]

Analysis Requested: Anions, Cations, Alkalinity, Carbonate, Bicarbonate, Hydroxide, Total Hardness, TDS, NO3 NO2, Metals, As, Cr, See Table 1 for all analytes

Preservative

Container Type and Size

Field Sample No./ Identification	Date	Time	Sample Matrix	Total No. of Cont.	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Remarks
CW-04-01-000526	5/26/00	9:45	GW	10			Y	Y			X		Y	Y		Y	
CW-04-02-000526	5/26/00	10:30	GW	10			Y	Y			Y		Y	Y		Y	

Relinquished by: (Print Name/Affiliation)	Date	Received by: (Print Name/Affiliation)	Date	Analytical Laboratory (Destination):
Tim Rusnells/SMI Signature: [signature]	Date: 5/26 Time: 5:45	Signature:	Time:	SMI Government Gulch Boise, ID 83837
Relinquished by: (Print Name/Affiliation) Signature:	Date: Time:	Received by: (Print Name/Affiliation) Signature:	Date: Time:	
Relinquished by: (Print Name/Affiliation) Signature:	Date: Time:	Received for lab by: (Print Name) Signature:	Date: Time:	Condition/Temperature of Samples when Received:

Serial No.: No 3572

White: Return to SMI Yellow: Laboratory Pink: Field Team

Matrix Codes: SW = Surface Water GW = Ground Water S = Soil/Sediment ___ = _____

SHEPHERD MILLER
INCORPORATED

CHAIN OF CUSTODY RECORD
REQUEST FOR ANALYSIS

Shepherd Miller, Inc.
3801 Automation Way #100
Fort Collins, CO 80525
(970) 223-9600 Fax (970) 223-7171

Client/ Project Name: City of Fallon

SMI Contact / Phone Number: Tim Russells 970-223-9600

Project Number: 100623 P.O. Number:

Delivery Method / Shipping Document Number: Fed-Ex

Send Results / Report To: Tim Russells, Shepherd Miller, Inc., 3801 Automation way, Ft. Collins, Co 80525

Sampler (Print Name / Affiliation): Tim Russells/SMI, Gary Everitt/WWC

Signature:

Analysis Requested: Gross Alpha, Ra 226, Ra 228, Uranium, Arsenic, Arsenic, Arsenic, Radon

Preservative: HNO3, HCl, HNO3, HNO3, HNO3, HNO3, DU

Container Type and Size: 1 Liter HDPE, 1 Liter HDPE, 1 Liter HDPE, 1 Liter HDPE, 1 Liter HDPE, 1 Liter HDPE, Glass Jar

See Table for all analytes

Field Sample No./ Identification	Date	Time	Sample Matrix	Total No. of Cont.	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Filt. Y	Filt. N	Remarks
CW-04-01-000526	4/26/00	8:45	GW	10		X	X		X			X			X		
CW-04-03-000526	4/26/00	10:40	GW	10		X	X		X			X			X		

Relinquished by: (Print Name/Affiliation)	Date:	Received by: (Print Name/Affiliation)	Date:	Analytical Laboratory (Destination):
Tim Russells/SMI Signature:	4/26/00 Time: 6:40	Signature:	Time:	SVL 200 Gowanus Gulch Lewiston ID 83537
Relinquished by: (Print Name/Affiliation) Signature:	Date: Time:	Received by: (Print Name/Affiliation) Signature:	Date: Time:	
Relinquished by: (Print Name/Affiliation) Signature:	Date: Time:	Received for lab by: (Print Name) Signature:	Date: Time:	Condition/Temperature of Samples when Received:

Serial No.: No 3571

White: Return to SMI Yellow: Laboratory Pink: Field Team

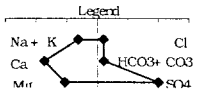
Matrix Codes: SW = Surface Water GW = Ground Water S = Soil/Sediment ___ = _____

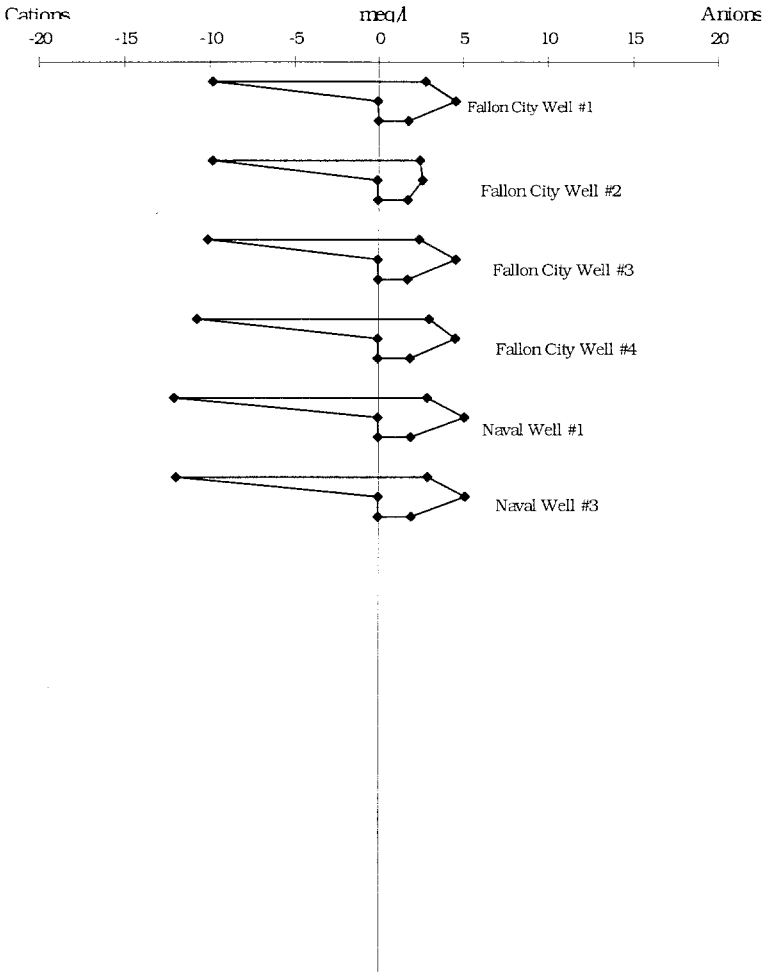
APPENDIX D

STIFF DIAGRAMS

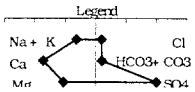
DRAFT

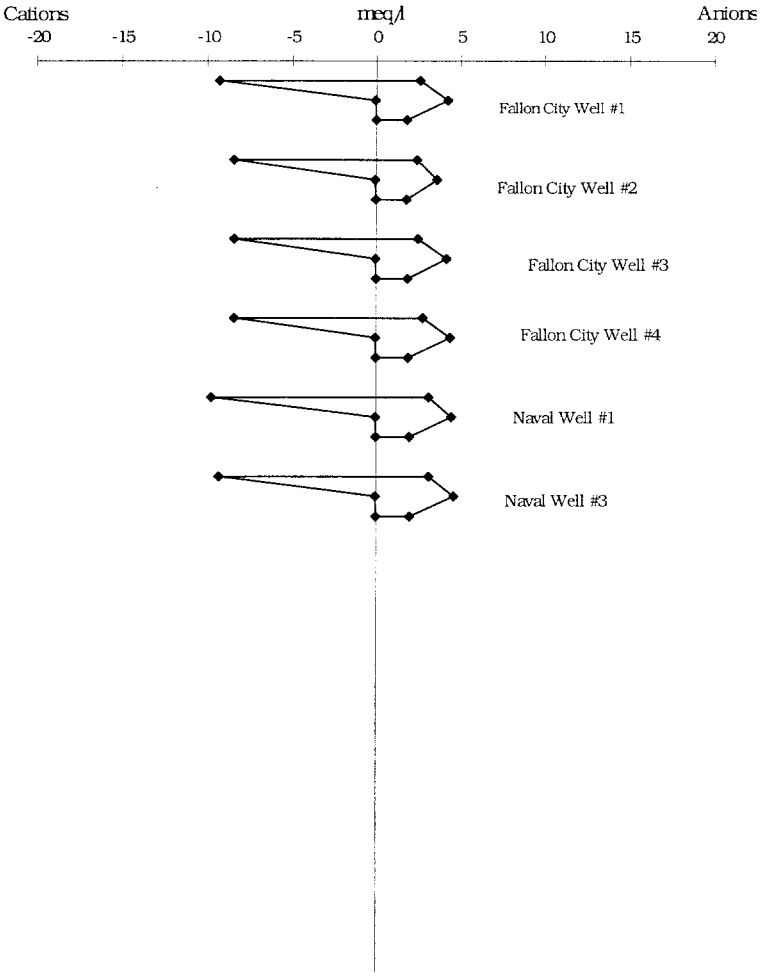
Stiff Diagrams
AAL Data Set



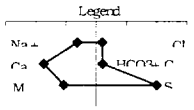


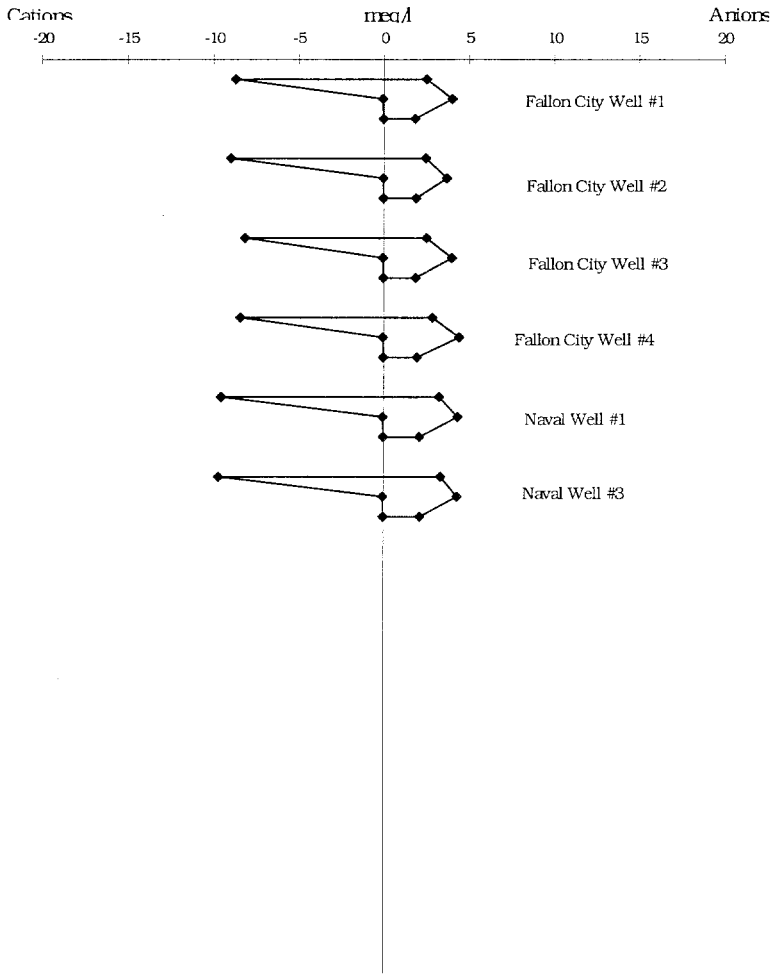
Stiff Diagrams
SEM Data Set





Stiff Diagrams
SVL Data Set





○