Proposed Process to Address the Historic Distribution of Sewage Sludge Containing Plutonium Released from the Lawrence Livermore National Laboratory

CALIFORNIA DEPARTMENT OF HEALTH SERVICES

Gray Davis, Governor

Grantland Johnson, Secretary, Health and Human Services Agency

Diana M. Bontá, R.N., Dr. P.H., Director, Department of Health Services

November 2002

Proposed Process to Address the Historic Distribution of Sewage Sludge Containing Plutonium Released from the Lawrence Livermore National Laboratory

Prepared by:

Environmental Health Investigations Branch,
California Department of Health Services

Preparers of Report

Tracy Barreau, R.E.H.S
Environmental Scientist
Environmental Health Investigations Branch
California Department of Health Services

Marilyn C. Underwood, Ph.D.
Staff Toxicologist
Environmental Health Investigations Branch
California Department of Health Services

Gina Margillo
Community Education and Participation Coordinator
Environmental Health Investigations Branch
California Department of Health Services

Collaborators

Patrice Sutton
Western States Legal Foundation

Jeff Wong
Radiologic Health Branch
California Department of Health Services

Robert Gould, M.D.
Physicians for Social Responsibility

Jacque Touray
City of Livermore

Marylia Kelley
Tri-Valley CAREs

Pamela Evans
Alameda County Environmental Health

Jackie Cabasso
Western States Legal Foundation

BACKGROUND AND STATEMENT OF ISSUE

In 1989, the Agency for Toxic Substance and Disease Registry (ATSDR) completed a Preliminary Public Health Assessment that recommended that environmental data be reviewed to assess the potential that human health could have been affected by activities at the Lawrence Livermore National Laboratory (LLNL) Superfund site (1). The California Department of Health Services (CDHS), Environmental Health Investigations Branch (EHIB), is continuing health assessment activities for the LLNL site under a cooperative agreement with ATSDR.

This health consultation discusses the historic distribution (1958-1976) of sewage sludge from the Livermore Water Reclamation Plant (LWRP), which may have been contaminated with plutonium from LLNL. This health consultation is a follow-up to an earlier CDHS/ATSDR health consultation, in which we recommended, **"further evaluation of the distribution of contaminated sewage sludge throughout the Livermore Valley and other areas. This would include assessing the different avenues for gathering information on where sludge may have been distributed and if locations are identified that may have received contaminated sludge, assessing the feasibility of various approaches to characterize the potential plutonium in those areas"** (2). Specifically, this health consultation: 1) defines the historic practice of sewage sludge distribution at LWRP, 2) delineates how LWRP sewage sludge became contaminated with plutonium, and 3) provides a potential process to address community concerns relating to the historic distribution of sewage sludge, which includes data collection and community notification and education. In 1998, the U.S. Environmental Protection Agency (USEPA) suggested a similar process [Appendix A (Attachments)].

The Lawrence Livermore National Laboratory Site

The Livermore site is approximately 50 miles east of San Francisco. The LLNL site occupies 826 acres and is in the southeast section of the Livermore Valley in Alameda County. Since 1951, LLNL has been an active multi-program research facility, (mainly nuclear weapons research and development) which is operated by the University of California for the U.S. Department of Energy (DOE) (3). Many operations at LLNL handle or generate hazardous materials, mixed wastes and radioactive wastes. Some activities at LLNL have resulted in off-site contamination and the potential for exposure to the community of Livermore. In 1987, the United States Environmental Protection Agency (USEPA) placed the LLNL Site on the National Priorities List (NPL) of hazardous waste sites, due to volatile organic chemical (VOC) contamination in the groundwater (3).

In May 1999, CDHS/ATSDR released a health consultation which explored possible pathways (routes) for plutonium 239 (Pu 239) contamination found in Big Trees Park, a public park in Livermore approximately ½ mile west of LLNL. ATSDR evaluated potential exposures to children from inhalation and ingestion of soil containing the highest plutonium level [1.02 pCi/gram (pico curies per gram soil)or 0.038 Bq/g (becquerels per gram soil)] found in Big Trees Park. ATSDR concluded that the maximum concentration of Pu 239 found in Big Trees Park is not at a level of health concern (2). However, there was a need to identify the pathway for the Pu-239 in Big Trees Park so as to know if a problem existed elsewhere. According to

LLNL, the placement of soil containing Pu 239 contaminated sewage sludge was suggested as the most logical hypothesis for the route by which the Pu 239 contaminated Big Trees Park (4). According to LLNL, the Pu-contaminated sludge was a result of a 1967 unintentional release of Pu 239 to the sanitary sewer (4). Sewage sludge from LWRP was available to the public and/or local municipalities for use as a soil amendment from 1958 through 1976 (5). LLNL staff suggested that residents obtained sewage sludge from the LWRP for use in their yards, and also distributed the sludge in Big Trees Park (W. McConachie, LLNL, personal communication, July 1, 1997). CDHS contacted the Livermore Area Parks Recreation Department (LARPD) to learn whether they used sewage sludge during the landscaping of Big Trees Park. LARPD reviewed their records and informed us that sewage sludge was not used in Big Trees Park (2). While it is still unclear whether this was the mechanism by which the Pu 239 got into Big Trees Park, CDHS recommended that the historic distribution (1958-1976) of sewage sludge from the LWRP be further evaluated. This recommendation was based on the following: Pu 239 concentrations in sewage sludge as a result of the 1967 release were not adequately characterized; high alpha activity had been documented in digester sludge in 1967 and during other time periods (1964); monitoring for Pu 239 in processed sewage sludge at LWRP did not begin until 1973; and it is not known whether Pu-contaminated sewage sludge that was given to the public from 1958 through 1973 poses a potential health hazard (2).

In March 2000, CDHS formed a "sludge working group" (SWG) to collaboratively propose a potential process to address community concerns relating to the distribution of contaminated sewage sludge [Appendix A (Figure 1)]. The group met periodically in 2000 and 2001. The working group consists of community members, representatives from the following community-based organizations, state and local agencies: Western States Legal Foundation (WSLF); Physicians for Social Responsibility (PSR); Tri-Valley CAREs (Communities Against a Radioactive Environment); Alameda County Department of Environmental Health; CDHS-Radiologic Health Branch (RHB); LWRP; and CDHS/EHIB. Most of the people on the "sludge working group" are also members of the "LLNL Site team", formed by CDHS to assist ATSDR/CDHS with the public health assessment being carried out at the LLNL site. Given the limited historic information characterizing Pu levels in sludge, particularly during the 1960s, SWG members believe it is necessary to develop a process to address concerns about Pu-contaminated sludge; obtain additional information as to locations of sludge in the community; and provide a mechanism if further steps are indicated (e.g. sampling, clean-up, etc.). Before a process could be developed, it was necessary to gain a better understanding of the historic operations at LWRP relating to sewage sludge distribution. The sludge working group reviewed information provided by LWRP, and talked with former employees of LWRP who worked at the plant when sludge was given out to the public. The following sections provide information relating to radiological releases from LLNL to the sanitary sewer/LWRP, radiological measurements of LWRP sewage sludge and a summary of the historic operations at LWRP.

Historical Radiological Analysis of Sewage Sludge

Correspondence from LLNL to LWRP indicates LLNL first began monitoring for Pu 239 in processed sewage sludge at the LWRP in 1973 (9). Prior to 1973, available data include monitoring data from an unintentional release of plutonium by LLNL into the sanitary sewer

system in 1967, summary data presented in LLNL (formerly known as Lawrence Radiation Laboratory (LRL) in the 1960s) Environmental Reports, published during the 1960s through the early 1970s, and routine radiologic monitoring of LWRP effluent and digester sludge between 1960-1969, conducted by the State of California, Bureau of Radiologic Health (6-8). As discussed below, these data indicate time periods when high alpha activity (i.e., plutonium or other alpha emitters) was measured in digester sludge at the LWRP; however the levels of alpha activity detected in the available monitoring data may not be representative of the levels in the processed sewage sludge that was available to the public. Processed sewage sludge is the end result of the waste treatment process, after the sludge has left the digesters and is transferred to the sludge lagoons or drying beds where some mixing of other sludge and dilution would occur.

1967 Pu Release

Between May 25 and June 15 of 1967, an unintentional release of Pu 239/Americium 241 (Am 241) from LLNL (known as Livermore Radiation Laboratory (LRL) in 1967) to the city's sanitary sewer resulted in contaminating the sewage sludge at the LWRP (6). At the time of the incident, using routine monitoring data compiled by the LRL, LRL staff estimated that over a three week period, from May 25 to June 15, the laboratory discharged approximately 32 millicuries of Pu 239-Am 241 to the sewer (6). The LRL sewer monitor was inoperative for 5 of the 21 days in this time period, and LRL inferred the data points for the missing days (6). According to LRL's analysis of the incident, since low-level radioactivity was routinely released to the sewer from LRL's Building 127, the source of the releases could not be definitively established (6).

In addition to monitoring at LRL, on June 6, 1967, LLNL collected samples from LWRP to gain a better understanding of the amount of Pu 239-Am 241 released (6). Characterization of the sludge by LLNL was based on estimates from measurements of gross alpha activity (there were no direct measurement of Pu 239 at that time) in the liquid effluent and suspended sediment. There was no sampling of the waste solids from any part of the LWRP process (6). Since Pu 239 associates with solids, the amount of Pu 239 may have been underestimated because the activity in solids was never measured. Thus, it appears that Pu 239 concentrations in the sludge at LWRP that resulted from the 1967 release were not adequately characterized.

1960-1969 Routine Monitoring

CDHS staff reviewed historic (1960-1969) effluent and sewage sludge radiologic data from the RHB of CDHS (formerly known as the State of California, Department of Public Health, Bureau of Radiologic Health) (8). These data were part of the State of California's radiologic monitoring of public sewage treatment facilities. LWRP collected monthly effluent and digester sludge samples, which were sent to RHB for analysis. Historic concentrations of alpha activity as high as 297 pCi/g [11.0 Bq/g] were measured in digester sludge from LWRP in 1964. In May and June of 1967 (general time frame of the documented unintentional release), alpha activity was reported at a concentration of 258 pCi/g (9.6 Bq/g) and 229 pCi/g (8.5 Bq/g), respectively (8). While these data indicate high levels of alpha activity, they may not be representative of alpha activity that could be found in processed sewage sludge, the form of sludge that was available to

the public (8). Thus, the level of radioactivity present in sludge given to the public throughout the 1960s remains unclear (data gap).

1973-1975 and 1990 LLNL Sludge Sampling

LLNL sampled processed sewage sludge at LWRP in 1973, 1974, 1975 and 1990. The highest concentration of Pu-239 reported was 4.4 pCi/g (0.16 Bq/g), in sludge collected from the drying beds in 1975 (10). This value exceeds the USEPA Preliminary Remedial Goal (PRG) level (2.5 pCi/g) the USEPA considers clean-up (removal) activities for residential areas (11). The PRG is a health protective screening level that represents a level of Pu 239 that could result in an increased cancer risk of one-in-a-million, from 30 years of exposure. The limited data from the mid-1970s indicates the possibility that levels could have been higher than the PRG (10-12).

CDHS is not aware of any unintentional releases of Pu-239 during the mid-1970s that were of similar magnitude as releases in 1964 and 1967. Therefore, it is not appropriate to consider that Pu 239 levels measured in the mid-1970s are representative of Pu 239 levels in sludge distributed throughout the 1960s.

1975 LLNL Study (Evaluation of the Use of Sludge Containing Plutonium as a Soil Conditioner for Food Crops(12))

In 1975, LLNL conducted a study evaluating the possible health implications from the use of sewage sludge containing Pu 239 as a soil amendment (12). Samples of sludge were collected from the drying beds at LWRP, with concentrations ranging from 2.2 pCi/g (0.08 Bq/g) to 4.4 pCi/g (0.16 Bq/g). LLNL used the average concentration, 2.8 pCi/g (0.10 Bq/g) to estimate 50-year radiation doses from inhalation of dust containing Pu 239 and ingestion of vegetables grown in Pu-contaminated sludge. LLNL concluded that the estimated radiation doses were below the "annual maximum permissible dose" and "represent a very small fraction of the recommended limits for non-occupational exposures" (12).

As stated above, there were no documented releases during the mid-1970s that correlate with the 1960s data. Therefore, this study cannot be considered an adequate assessment of the potential health implications posed by sludge distributed in the 1960s, when high levels of alpha activity were measured.

History of LWRP Operation Relating to Sewage Sludge Distribution

In order to better understand the time periods and amount of sludge that was given out to residents, the SWG tried to clarify LWRP operations during the 1960s and 1970s [Appendix A (Table 1)]. Below, LWRP operations will be described by time periods relative to various expansions at the plant. We will also discuss locations of known sludge disposition. The sources of information used to develop this summary include a sludge disposition and construction time line provided by LWRP staff, and communications with former staff of LWRP (the superintendent, a chemist, and a water treatment plant operator) (5,13). These former employees all worked at LWRP during the years the sludge was distributed.

1958-1965:

During this time period the plant used four sludge drying beds, which were approximately 22,000 ft^2 [Appendix A (Figure 2)]. In the drying beds, the sludge was placed on a 12-18" layer of sand, which covered tile drains that carried off the liquids draining from the sludge (13). The four drying beds were filled yearly, resulting in a deposition of about 4 inches of dried sludge. Once the sludge was dry it was hammer milled and ground. The sludge was given out to the public and local agencies. Treated liquid effluents were placed in oxidation ponds, which covered approximately 37 acres [Appendix A (Figure 2)]. Liquid effluents were then discharged to the Arroyo Seco and Arroyo Las Positas (13).

1965-1967:

Between 1965-1967, "phase II" expansion was underway, which included the addition of two sludge lagoons [Appendix A (Figure 2)]. The sludge lagoons had a capacity to hold five to seven years of waste. The oxidation ponds were shortened and liquid effluents were disposed of at the airport, and discharged into the Arroyos. Distribution of sludge to the public was very limited (if any) due to construction activities at the plant. The sludge remained in the drying beds for about one year before it was mixed and given out. If the release occurred in 1967, the affected sludge should not have been given out until some time in 1968.

1967-1976:

Phase III expansion was completed in 1973, with the addition of a third sludge lagoon [Appendix A (Figure 2)]. In 1974, the third sludge lagoon was used as an overflow for lagoons #1 and #2 (5). During this time, sludge was periodically given to the public, local agencies, and it was hauled and disposed of at the Altamont/Vasco Road landfill (12). According to the former workers, distribution of sludge to the general public was stopped after the 1973 LLNL Annual Report was published, which revealed detectable levels of Pu 239 in sludge in the LWRP drying beds. However, sludge was still given out to local agencies until about 1976 (13). Some sludge was stockpiled at the airport. Sludge was also disposed of at a 200 acre ranch, adjacent to LWRP. In 1969, the golf course and arroyos received liquid effluents from LWRP.

Location of Known Sludge Disposition:

LWRP staff reported that residents who received LWRP sludge signed a log book with their name and address. In 1997 and 1998, as part of the Big Trees Park health consultation activities, CDHS requested a copy of the log book from the City of Livermore (2). The city was not able to locate the log book (2). According to LWRP staff, LLNL copied the log book in the early 1970s, when Pu 239 was first measured in LWRP sludge (12). Based on this information, CDHS and other members of the SWG requested the log book from LLNL. In response to a Freedom of Information Act request for the log book, LLNL indicated "no documents responsive to your request were found" (14). Current LWRP staff undertook another search of their records and archives and could not locate the book. Ultimately, CDHS was not able to obtain information that identifies residential uses/locations of sewage sludge. It is important to note that the amount

of time that has passed since sludge was given out (25-40 years), may present a substantial barrier to locating many residential areas that received sludge.

According to the former LWRP staff, the majority of the sludge was taken by the Livermore Area Recreation and Parks Department (LARPD) for use in median strips, ball fields and other municipal projects (13). Based on the information reviewed, there are several places where sludge was deposited, which could serve as initial sampling locations if the sludge issue is further evaluated. These areas are as follows:

- 200-acre ranch adjacent to LWRP;
- stockpile areas at airport;
- tree wells at LWRP (all trees planted in sludge during the late 1960s);
- former LWRP employee's yard(s);
- rose garden at Great Livermore Junction/Portola Road;
- ½-acre worm farm on Buena Vista Avenue (1973);
- LWRP drying beds (limited contact with soils due to sand layer and tile drains).

CDHS has provided a table that summarizes the available data discussed in this health consultation [Appendix A (Table 1)].

DISCUSSION

Proposed Process for Addressing Historic Sludge Distribution

The available data indicate an indeterminate public health hazard for the following reasons: 1) sludge at LWRP was contaminated by routine and unintentional releases of plutonium from LLNL; 2) over a period of 18 years, sludge from LWRP was distributed to community members and to the Livermore Area Recreation and Parks Department for use as a soil amendment; the amount of sludge distributed, and the concentration of radioactivity in the sludge are uncertain; 3) while it is unclear the level of radioactivity present in sludge given to the public, the limited data indicates the possibility these levels could have been higher than the USEPA Preliminary Remedial Goal; 4) seven Livermore locations were identified as having received sludge; CDHS has been unable to identify other locations.

The SWG felt that more information was needed and that members of the community should be provided information ("community right-to-know"[1]) about historic sludge contamination. Since the nature and extent of the potential health hazard remains uncertain, members supported a process that approaches these issues in a proactive manner and would be based on the

[1] **Community Right-to-Know**: Title III of Superfund law: In 1986 Superfund law was amended with a provision added to help increase the public's knowledge and access information on the presence of hazardous chemicals in their communities and releases of chemicals into the environment. (USEPA Superfund: www.epa.gov/oerrpage/superfund/programs/er/comunity/rt2know.htm)

"precautionary principle"[23]. A key component of the precautionary principle is to take precaution in the face of scientific uncertainty. The right-to-know approach is based on the fact that community members were not made aware of the potential for plutonium contamination when, or after, they received the sludge**.**

The SWG developed a process to address the uncertainties associated with the historic distribution of sludge through the definition of goals and objectives. The "goals" were defined as what the process is designed to accomplish, and "objectives" are the activities used to achieve the goals. The following provides a brief description of the process identified by the SWG.

This process would be carried out with the goals of informing the impacted community about the sludge issue, better defining whether a potential health risk exists, and providing options if further steps are indicated. Objectives for this process would include: informing and soliciting further information from residents who may have obtained sludge; sampling known areas of sludge disposition in order to gain a better understanding if there is a potential health risk; establishing criteria for sampling residences and interpreting results and; providing a mechanism for sampling and, if necessary, removing Pu-contaminated sludge.

A community notification and education program is proposed, which may consist of door-to-door notices of public meetings, careful discussions of the potential health impact (at all potential levels) with NGO (non-governmental organization) and local government representation. A local toll free telephone number, through Alameda County Department of Environmental Health, would be available for community members to receive information about sludge distribution and resources if further steps are deemed appropriate. It is important to have a mechanism to address fear and anxiety which could be generated by the process. Having the toll free line available may help in providing accurate information and referrals, and thus alleviate undue stress. The toll free line would also serve as a vehicle to receive additional information about potential locations of sludge in the community. This process would also include sampling known areas of sludge disposition. All sampling results will be communicated to the public. In the absence of a broader understanding of sludge use patterns, it cannot be assumed that sampling at known areas of sludge disposition will provide results representative of levels that may be present at other households or locations.

In a letter sent to DOE, the USEPA made similar suggestions regarding the need to further investigate sludge distribution, potential sampling of residences that may have received sludge and

---

[2] **Precautionary Principle:** When information about potential risks is incomplete, basing decisions about the best ways to manage or reduce risks on a preference for avoiding unnecessary health risks instead of on unnecessary economic expenditures. (USEPA Terms of the Environment: http://www.epa.gov/OCEPAterms/pterms.html)

[3] **Precautionary Principle**: When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause-and-effect relationships are not fully established scientifically. (Science and Environmental Health Network. Fact Sheet: The Precautionary Principle -A Common Sense Way to Protect Public Health and the Environment).

setting up a call-in number for community members to receive information [Appendix A (Attachments)].

The SWG developed a flow chart for carrying out the process [Appendix A (Figure 1)]. Once funding is secured, establishment of a steering committee to guide the process and sub-committees tasked with specified activities may be the next appropriate step. The SWG identified three potential sub-committees: 1) a technical sub-committee that would be responsible for developing criteria related to sampling, evaluating any additional data related to LWRP sludge, interpretation of results, removal activities and physician referral; 2) a health education sub-committee that would be responsible for developing health education materials and an outreach plan and; 3) a policy sub-committee to address political issues (local level) that could arise from this effort. Next, public outreach and awareness activities are implemented and the toll free phone number is available for a specified time frame (defined by steering committee). The next step involves environmental sampling, which would include known areas of sludge disposition and residential sampling. The number of calls received and/or residences meeting the sampling criteria will determine the extent of sampling. The process for determining residential sampling locations makes use of information gained about LWRP operations and historic radiological measurements. The specific circumstances of each situation would help define the likelihood of sludge being present, the ability to locate the sludge and the feasibility of testing. For example, if a resident never obtained sludge, but is worried that sludge may have been used in their landscaping, the person receiving the call (county contact) would ask a set of questions to better understand whether the home could have received sludge. The county contact learns that the house was built in the 1980s, when sludge was no longer being given out. The resident is then informed that it is unlikely that Pu-contaminated sludge is present. Thus, sampling would not be recommended in this case. On the other hand, if a resident calls who received sludge in the 1960s, knows where the sludge was placed, it may be determined that sampling is an appropriate step. The final step includes analysis of results, determination of next steps (removal activities, physician referral, health education, etc.) and informing the public.

Issues Needing Further Consideration:

The SWG also identified other issues needing consideration before any process can be implemented, especially if sampling is involved:

- A budget should be developed and a funding source secured to implement a process, which would potentially include sampling and removal activities. Potential funding sources include: responsible parties; federal regulatory agency.

- Before sampling is undertaken, criteria for the type of laboratory analyses, and the interpretation of results must be established. LLNL, USEPA, CDHS and ATSDR may be able to provide consultation in these areas. However, consultation with an independent health physicist will also be essential for this process.

- A threshold level (level of Pu which would result in removal; possibly the USEPA Preliminary Remedial Goal) and mechanism for removal of Pu-contaminated soils should

be established. As the responsible party, LLNL/DOE would be the most likely entity to provide resources to complete removal activities meeting the established criteria, with independent review.

- Legal disclosure of sampling results. Loss in property value and likelihood of compensation. Community members must be informed of these issues prior to any sampling activity. Community cooperation and involvement will be substantially affected by these issues.

CDHS/EHIB staff believe that community involvement/participation in carrying out any process to address the sludge issue is critical to the success of the project. Given the continued efforts by Alameda County Department of Environmental Health staff to understand and be responsive to radiological issues in their county, we believe they are the most appropriate agency to implement a process, if funding can be secured. It would be useful for Alameda County to work collaboratively with other agencies, such as CDHS and USEPA, for support and expertise in health education activities and radiologic issues. We would also encourage a continued partnership with community members and citizen groups, such as Tri-Valley CAREs, WSLF and PSR.

ATSDR Supplemental Information

In June 2002, in an effort to address the potential health implications of Pu-contaminated sludge, ATSDR released a draft exposure assessment evaluating the historic monitoring data sewage sludge from LWRP. ATSDR reviewed the gross alpha measurements in LWRP sludge in an attempt to answer two questions: 1) what level of Pu 239 in sludge would result in a radiological dose of health concern and; 2) were the Pu 239 levels in LWRP sludge ever high enough to be a health concern (15). ATSDR calculated that the alpha levels in sludge would have needed to be 560 pCi/g to be a level of health concern. ATSDR uses a minimal risk level (MRL) of a 100 millirem per year (mrem/yr; above background) effective dose limit as the basis for comparison. An MRL is defined as, "an estimate of daily human exposure to a dose of radiation or chemical that is likely to be without appreciable risk of adverse noncancerous effects over a specified period of time". The MRL for ionizing radiation includes cancerous health effects (15). ATSDR concluded that historic levels in LWRP sludge would not have resulted in exposure doses exceeding 100 mrem/year and therefore, not a health concern. ATSDR is in the process of expanding the sludge exposure assessment into a focused public health assessment. The ATSDR exposure assessment (pending health assessment) should be evaluated as part of the process proposed in this health consultation.

It would also be helpful for any future process to consider other dose limits that are used in decisions relating to clean-up or regulatory purposes at CERCLA (NPL) sites. From a regulatory perspective, the USEPA does not consider the effective dose limit of 100 mrem/year protective of health because it equates to an "unacceptably high" increased cancer risk of approximately 2 in 1000. The USEPA suggests that levels of 15 mrem/year effective dose (which equates to an increased cancer risk of about 3 in 10,000) or less are health protective and achievable (16).

Children's Health Issues

CDHS recognizes that children can be more sensitive to health effects caused by environmental contaminants, and believes that it is important to search for additional information that will increase our understanding of the contaminants, and ensure that the children's health is protected. If additional environmental data becomes available as a result of this health consultation, any health interpretation should use the most conservative assumptions to be protective of children over periods of time commensurate with the longevity of the radiologic hazard.

CONCLUSION

CDHS/EHIB formed a working group to develop a process to address concerns about the historic distribution of potentially contaminated (Pu 239) sewage sludge from the LWRP. The historic operations at the LWRP relating to sludge distribution and measurements of radioactivity were documented, which provides insight into the distribution of sludge during different time periods. This information indicate a data gap during the 1960s, relative to Pu concentrations in sewage sludge given to the public. During this time period high levels of alpha activity were measured in sludge at LWRP, but there were no actual measurements of Pu 239 in the sludge given to the public. An absence of these data prohibit the ability to adequately evaluate the potential health hazard from exposure to Pu 239 contaminated sludge which was distributed to the public throughout the 1960s.

In 1975, LLNL conducted the first evaluation of the potential health implications from the use of contaminated sludge, using data collected in 1973. LLNL concluded radiation doses were within acceptable levels for the public. There were no documented Pu releases during the mid-1970s that correlate with the 1960s data. Therefore, this study cannot be considered an adequate assessment of the potential health implications posed by sludge distributed during the 1960s, when high levels of alpha activity were measured.

In June 2002, in a draft exposure assessment, ATSDR used historic measurements of alpha activity in LWRP sludge to estimate the level of Pu-contaminated sludge necessary to result in a health concern. ATSDR concluded that Pu 239 levels in LWRP sludge would not have resulted in exposure doses exceeding 100 mrem/yr and not a public health concern. This information should be evaluated as part of the process proposed in this health consultation.

In addition to the ATSDR exposure assessment, dose limits suggested by the USEPA for CERCLA sites should be considered during the implementation of the proposed process. The USEPA suggest the use of lower dose limits (15 mrem/yr) for regulatory purposes. These levels are considered more health protective, based on the increased risk of developing cancer from exposure to ionizing radiation.

CDHS and the SWG recommend that DOE/LLNL fund Alameda County to implement a process to address the historic distribution of sludge from LWRP. Based on the available information, the SWG developed a process to address concerns relating to sludge distribution. The process is based

on the "community's right to know" and data collection. Any process undertaken should be carried out in collaboration with interested community members and citizens groups.

CDHS concludes that the historic distribution (1958-1976) of sewage sludge from LWRP poses an indeterminate health hazard due to a lack of data.

Public Health Recommendations and Actions

The Public Health Recommendations and Actions Plan (PHRAP) for this site contain a description of actions taken, to be taken, or under consideration by ATSDR and CDHS at and near the site. These recommendations are based on the findings presented in this health consultation.

Actions Completed

1. CDHS completed a health consultation which evaluates potential routes for the plutonium contamination in Big Trees Park (May 1999).

2. ATSDR completed a health consultation which evaluates the 1998 sampling in Big Trees Park (January 2000).

3. CDHS released a public comment draft health consultation which describes community health concerns relative to the LLNL Site (May 2002).

4. ATSDR released a public comment draft health consultation which evaluates potential exposures from tritium releases in 1965 and 1970 (August 2001).

5. ATSDR released a public comment draft health consultation which describes the conclusions of an expert panel's review of tritium analyses used by LLNL (August 2001).

6. ATSDR released for public comment a draft health assessment which evaluates potential exposures from tritium releases in 1965 and 1970 (July 2002).

Actions Planned

CDHS will construct a health consultation describing health studies conducted in Livermore, relating to the LLNL Site.

Recommendations for Further Actions

CDHS and the SWG recommend that LLNL/DOE provide funding to Alameda County Department of Health Services to implement a process to address the historic distribution of sludge from LWRP.

References

1. Agency for Toxic Substances and Disease Registry. Preliminary Public Health Assessment. U.S. Department of Health and Human Services; 1989 April

2. Environmental Health Investigations Branch, California Department of Health Services. Health Consultation Plutonium in Big Trees Park, Lawrence Livermore National Laboratory. Prepared for the Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services; 1999 May.

3. Lawrence Livermore National Laboratory. Final Environmental Impact Statement and Environmental Impact Report for the Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratory; 1992 August. SCH90030847.

4. United States Environmental Protection Agency. Lawrence Livermore National Laboratory Plutonium Fact Sheet; 1995 September.

5. City of Livermore Water Reclamation Plant. Construction and Sludge Disposition Time line; FAX transmittal from Jacque Touray; 25 April 2000.

6. Lawrence Radiation Laboratory (LRL). Letter to E.C. Shute, U.S. Atomic Energy Commission from D.C. Sewell, Associate Director, LRL re: Summary Hazards Analysis: Pu Am Release to Sanitary Sewer. 1967 August 22.

7. Lawrence Radiation Laboratory (LRL). Semi Annual/Annual Environmental Reports. 1961-1969; 1972-1974.

8. California Department of Health Services, Radiologic Health Branch. Data sheets entitled Gross Radioactivity in Sewage Samples: 1960-1969.

9. Lawrence Livermore National Laboratory. Letter to Dan Cloak (LWRP) from Harry Galles (LLNL) re: Plutonium at the Water Reclamation Plant. 1990 December 4.

10. Lawrence Livermore National Laboratory. Letter to Dan Cloak (LWRP) from Harry Galles (LLNL) re: Historical Measurements of Plutonium at the Water Reclamation Plant. 1990 December 10.

11. United States Environmental Protection Agency. Radiation Site Cleanup Regulations: Technical Support Document of Radionuclide Cleanup Levels for Soil. Office of Air and Radiation; Draft September 1994.

12. Myers, D. S., et al. Lawrence Livermore National Laboratory. Evaluation of the Use of Sludge Containing Plutonium as a Soil Conditioner for Food Crops. Livermore, CA: Prepared for presentation at the International Symposium on Transuranium Nuclides in the Environment, San Francisco, Nov. 17-21, 1975, sponsored by the IAEA, USERDA and LLL. 17 September 1975. Report No: UCRL-77318

13. California Department of Health Services. CDHS teleconference with Livermore Water Reclamation Plant retired staff; 16 August 2000.

14. United States Department of Energy. Letter to Tracy Barreau (CDHS) and Marilyn Underwood (CDHS) re: Freedom of Information Act Request - #2000-OK-42. 2000 May 5.

15. Agency for Toxic Substances and Disease Registry. Draft Exposure Assessment of Plutonium-Contaminated Sludge Emanating from the Lawrence Livermore National Laboratory; June 2002.

16. United States Environmental Protection Agency. Memorandum: Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination. Office of Solid Waste and Emergency Response; 27 August 1997. OSWER No. 9200.4-18.

APPENDIX A
(Figures, Tables, Attachments)

FIGURES

Figure 1. Process to Address Historic Sludge Distribution

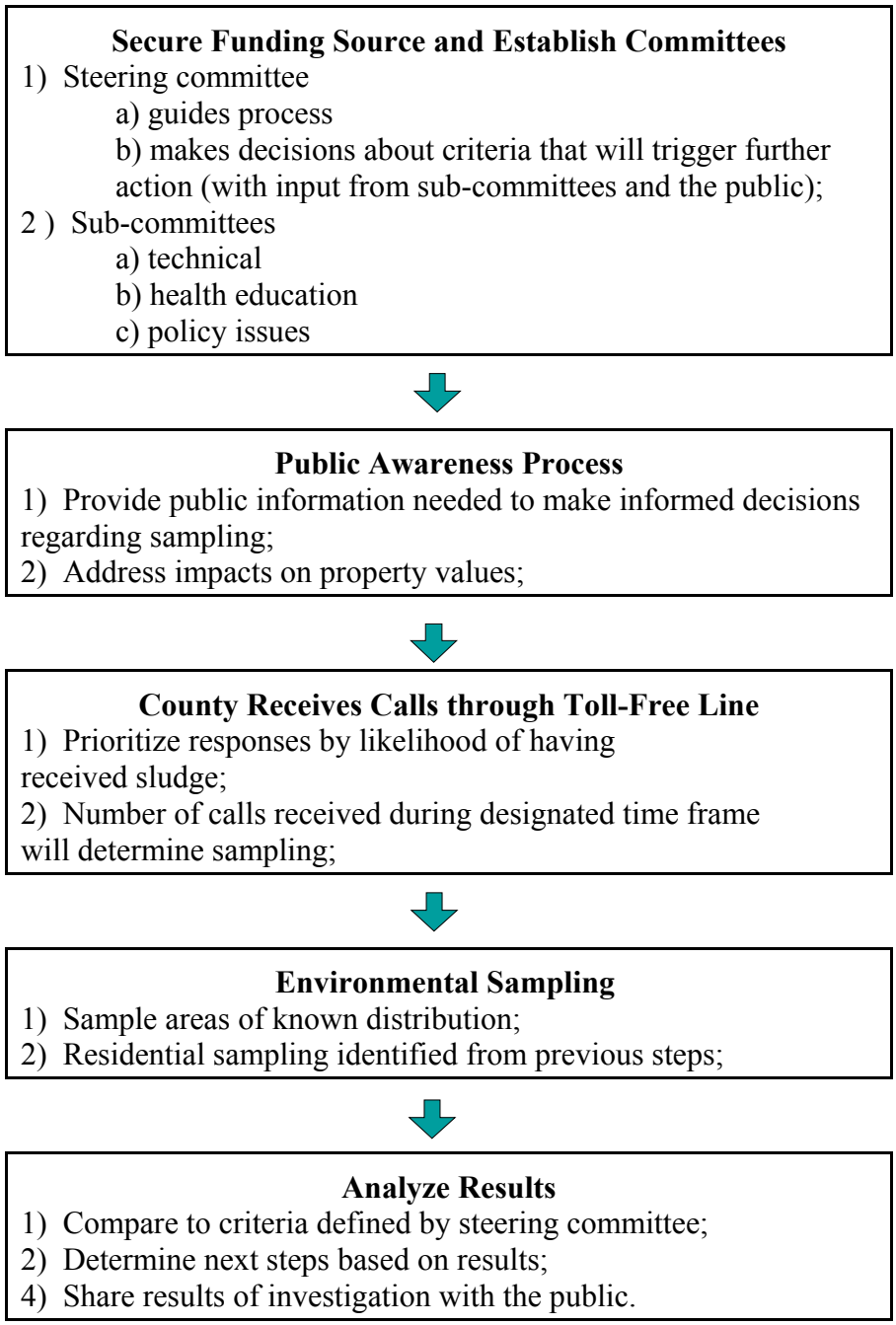
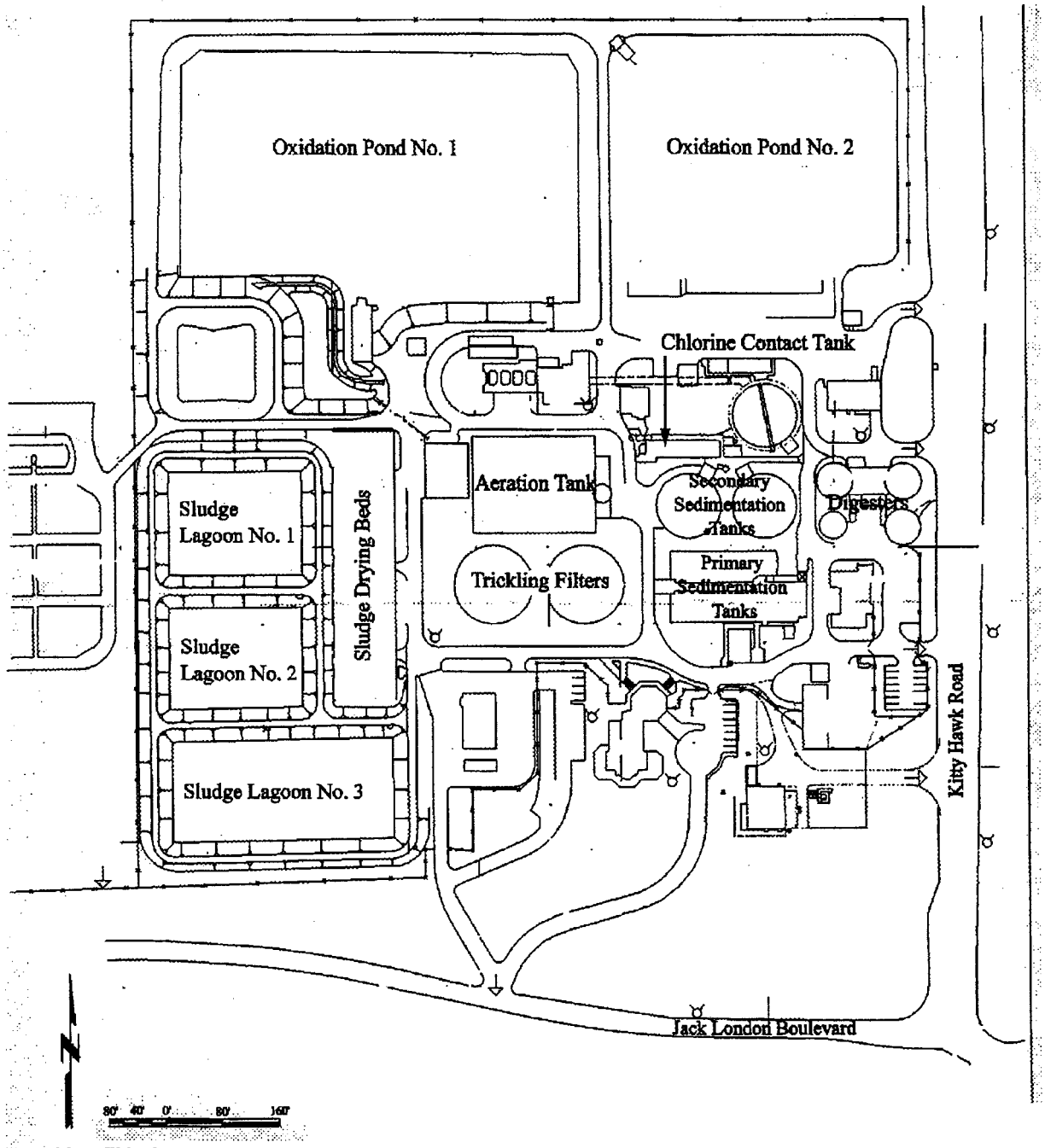


Figure 2. Location of Historic Process Areas at the Livermore Water Reclamation Plant, 1965-1976



Note: This plan was developed using a March 2000 site plan of the Livermore Water Reclamation Plant.
The labeled areas on this site plan reflect the locations of historic processes discussed in this health consultation.

TABLES

Table 1. Summary of Available Data About Sludge Distributed by the Livermore Water Reclamation Plant

What is known about where the sludge was distributed	What is known about the concentration of plutonium in sludge
1958-1976: Sewage sludge from Livermore Water Reclamation Plant (LWRP) available to the public and local municipalities for use as a soil amendment. According to the former LWRP staff, the majority of the sludge was taken by the Livermore Area Recreation and Parks Department for use in median strips, ball fields and other municipal projects.	**1958-1972:** No monitoring of plutonium levels in processed sewage sludge distributed to the public.
1958-1965: Sludge given out to the public and local agencies. Liquid effluents discharged to the Arroyo Seco and Arroyo Las Positas.	**1960-1969:** State of California, Department of Public Health, Bureau of Radiologic Health, conducts radiologic monitoring of public sewage treatment facilities. LWRP collects monthly effluent and digester sludge samples* which are sent to the Bureau of Radiologic Health for analysis. LLNL Environmental Reports provide summary data on alpha activity in sludge.
	1964: Alpha activity as high as 297 pCi/g [11.0 Bq/g] measured in dried digester sludge from LWRP during routine monitoring by State of California, Department of Public Health, Bureau of Radiologic Health.
1965-1967: Distribution of sludge to the public is very limited (if any) due to constructions activities at the plant. Liquid effluents disposed of at the airport, and discharged into the Arroyos.	
Late 1960s: all trees at LWRP planted in sludge.	
1967-1976: Sludge given to the public, local agencies, and hauled and disposed of at the Altamont/Vasco Road landfill (12). Some sludge stockpiled at the airport. Sludge also disposed of at a 200 acre ranch, adjacent to LWRP.	**1967**: Between May 25 and June 15, Pu 239/Americium 241 unintentionally released from LLNL to the city's sanitary sewer. The release resulted in contaminating the sewage sludge at the LWRP (6). The amount if plutonium released is not known. **1967**: In May and June of 1967 alpha activity in dried digester sludge reported by the State of California Bureau of Radiologic Health at a concentration of 258 pCi/g (9.6 Bq/g) and 229 pCi/g (8.5 Bq/g), respectively (7)

TABLE 1 - *Continued*	
What is known about where the sludge was distributed	**What is known about the concentration of plutonium in sludge**
1968: Sludge remains in the drying beds for about 1 year before it is mixed and given out to the public. Sludge potentially affected by the 1967 releases begins to be given out.	
1969: Golf course and arroyos receive liquid effluents from LWRP. Sludge used in former LWRP employee's yard(s).	
1973: Distribution of sludge to the general public stops after the 1973 LLNL Annual Report published, which revealed detectable levels of Pu 239 in sludge in the LWRP drying beds. Sludge still given out to local agencies. Half-acre worm farm on Buena Vista Avenue received sludge**.**	**1973**: First monitoring for Pu 239 in processed sewage sludge at LWRP begins. The 1973 LLNL Annual Report reveals detectable levels of Pu 239 in sludge in the LWRP drying beds.
1975: Sludge used in former LWRP employee's yard(s).	
1973: Sludge used in rose garden at Great Livermore Junction/Portola Road.	**1975**: The highest concentration of Pu 239 in processed sewage sludge (4.4 pCi/g; 0.16 Bq/g) reported in the drying beds. This value exceeds the USEPA Preliminary Remedial Goal (PRG) level (2.5 pCi/g) the USEPA considers clean-up (removal) activities for residential areas.
1976: LWRP stops distributing sewage sludge to the local agencies.	

***** These levels may not be representative of alpha activity that could be found in processed sewage sludge, the form of sludge that was available to he public. Processed sewage sludge is the end result of the waste treatment processes after the sludge has left the digesters and is transferred to the sludge lagoons or drying beds, where some mixing with fresh sludge and uncontaminated soils would occur.

ATTACHMENTS
(USEPA letter dated 3/5/98)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

March 5, 1998

Mr. Roger Liddle
U.S. Department of Energy
Operations Office
1301 Clay Street
Oakland, CA 94612

Re: Future Work Regarding
Plutonium in Big Trees Park

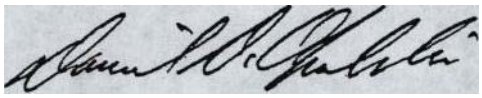
Dear Mr. Liddle

As you know, the recently released ATSDR/California DHS health consult entitled Lawrence Livermore National Laboratory Plutonium Contamination In Big Trees Park, Livermore, Alameda County, California and dated February 9, 1998 contains recommendations based on the authors' concerns about uncertainties regarding past plutonium releases from LLNL. Although the 1995 sampling results from the park showed no unacceptable health hazards, we have to acknowledge that past efforts left questions unanswered. While those involved in this 1995 sampling effort (consisting of EPA, Cal DHS and DOE) have up to this point been comfortable with the extent of the available information, public health experts now have clearly indicated that more should be done to address certain unknowns. Regardless of whether flaws remain in their report, ATSDR and California DHS are unlikely to change their recommendations. Present and future residents have also added their sincere concerns whether enough is known about contamination in the park and the surrounding area.

We believe that the Department of Energy needs to take immediate measures to address the identified public health concerns. Although the Site Team, with stakeholder involvement, should design the specific activities to be carried out, some appropriate steps already have been outlined m the report. Additional deeper sampling at Big Trees Park needs to occur. A history of past sludge uses and other potential sources of the plutonium in the park need to be studied and presented in a more comprehensive fashion. The answer to the question of whether soil amended with contaminated sludge was used in parks and yards needs to be investigated. Providing a call-in number to the local community to answer questions about possible plutonium contamination may also be appropriate. Property that may have received sludge may need to be screened on a request basis. This is especially important if the source of the plutonium in the park is shown to be contaminated sewer sludge.

We believe a timely response to the ATSDR/California DHS recommendations will best help DOE and LLNL build trust and credibility within the community. The Site Team and the public expect and deserve to hear concrete answers to their questions at the next (May 13th) Site Team meeting. If sampling cannot be started by that date, at least a detailed schedule and a description of planned actions should be provided. Be assured that EPA is willing to assist with the planning and implementation of any response actions. If you have any questions, please call me at 415-744-2420 or Michael GUI of my staff at 415-744-2385.

Sincerely,



Dan Opalski
Branch Chief
Federal Facilities Cleanup Branch

cc: Michael Brown (DOE)
Paul Charp (ATSDR)
C. Joseph Chou (RWQCB)
Gwen Eng (ATSDR)
Harry Galles (LLNL)
Marylia Kelley (Tri-Valley CAREs)
Albert Lamarre (LLNL)
James Littlejohn (DOE)
Mark Piros (DTSC)
Marilyn Underwood (Cal DHS)