GEOTHERMAL RESOURCES DEVELOPMENT

State of Hawaii

C-100

State of Hawaii
DEPARTMENT OF LAND AND NATURAL RESOURCES
Division of Water and Land Development

Honolulu, Hawaii
March 1984
GEORGE R. ARIYOSHI
Governor

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PREFACE

The Geothermal Resources Development report was prepared to assist in the designation of geothermal resource subzones in the State of Hawaii as mandated by Act 296, SLH 1983, and contains a compilation of currently available information relating to geothermal development in Hawaii.

This report identifies the existing exploratory well sites, and outlines the current geothermal resource mining leases issued by the State Board of Land and Natural Resources. Also included is a list of geothermal exploratory drilling permits issued by the Department of Land and Natural Resources and special use permits issued by the County of Hawaii and the State Land Use Commission.

In order to demonstrate the feasibility of geothermal energy utilization, a brief outline of the HGP-A Well head Generator Project has been included. This information along with future contributions to the Department will be of valuable assistance in determining the location and quality of Hawaii's geothermal resources.
CONTENTS

Preface .................................................. iii
Illustrations .............................................. vii

Geothermal Resource Mining Leases (GRML) ..................... 1
  GRML, S-4602 ........................................... 1
  GRML, R-1 ............................................ 3
  GRML, R-2 ............................................ 5
  GRML, R-3 ............................................ 7
  GRML, R-4 (pending) .................................. 9

Drilling Permits Issued by the Department of Land and
  Natural Resources (DLNR) ............................ 11

Special Use Permits Issued by the County of Hawaii
  and the State Land Use Commission .................. 12

Geothermal Exploratory Wells ............................ 14

Campbell Estate Geothermal Project (Kahaualea) ............. 17

Geothermal Energy Production (HGP-A) ........................ 19

Summary of Monthly HGP-A Operating Figures ............... 22

References ............................................... 23
## ILLUSTRATIONS

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tax Map Key Showing Boundary of GMRL, S-4602</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Tax Map Key Showing Boundary of GMRL, R-1</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Tax Map Key Showing Boundary of GMRL, R-2</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>Tax Map Key Showing Boundary of GMRL, R-3</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>Tax Map Key Showing Boundary of GMRL, R-4</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>Portion of Puu Anahulu Quadrangle Map</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Showing Site of Geothermal Well FNB No. 2</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Portion of Pahoa South Quadrangle Map</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Showing Geothermal Well Sites Located in the Puna District</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Location Sketch of Proposed Campbell Estate Geothermal Project (Kahaualea)</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Showing Some of the 1983 Lava Flows</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Geothermal Power Plant Diagram</td>
<td>21</td>
</tr>
</tbody>
</table>
GEOTHERMAL RESOURCE MINING LEASES (GRML)

(1) Geothermal Resource Mining Lease: S-4602 (HGP-A)

Issued To: The Research Corporation of the University of Hawaii

Location: Kapoho, Puna, Hawaii

TMK: 1-4-01: Portion of 2 (currently indicated as parcel 82)

Area: 4.1 acres

Land Ownership: State of Hawaii

Effective Date: June 19, 1979

Term: 10 years primary, 35 years maximum

General Information:

- Well Drilled to Date: HGP-A
- Leased Area Zoned: Agriculture
- Mineral rights reserved to State of Hawaii
- See Figure 1
Figure 1. Tax Map Key Showing Boundary of GMRL, S-4602.
(2) Geothermal Resource Mining Lease: R-1

Issued To: Bishop Estate, Subleased to Puna Geothermal Venture (Thermal Power, Dillingham, Amfac)

Location: Puna, Hawaii

TMK: 1-3-01: 22, 23, 58, 59
1-3-02: 32, 33, 59, 79-84, 87
1-3-03: 5, 6, 41
1-3-09: 1, 2, 5, 8, 10

Area: 3,486.73 acres

Land Ownership: Bishop Estate

Effective Date: March 1, 1981

Term: 10 years primary, 65 years maximum

General Information:

- No exploratory drilling to date
- Portion of leased area zoned conservation (TMK: 1-3-09: Portion of 5), balance of area zoned agriculture
- Mineral rights reserved to State of Hawaii, subject to verification by Division of Land Management
- See Figure 2
Figure 2. Tax Map Key Showing Boundary of GMRL, R-1.
(3) **Geothermal Resource Mining Lease: R-2**

**Issued To:** Kapoho Land Partnership, Subleased to Puna Geothermal Venture (Thermal Power, Dillingham, Amfac)

**Location:** Kapoho, Puna, Hawaii

**TMK:** 1-4-01: 1, 2, Section of 3, 19, 58

**Area:** 815.799 acres

**Land Ownership:** Kapoho Land and Development Co., Ltd.

**Effective Date:** March 1, 1981

**Term:** 10 years primary, 65 years maximum

**General Information:**

- **Wells Drilled to Date:** Kapoho State No. 1 / K.S. No. 1-A
  Kapoho State No. 2

- **Leased Area Zoned:** Agriculture

- **Mineral rights reserved to State of Hawaii, subject to verification by Division of Land Management**

- **See Figure 3**
Figure 3. Tax Map Key Showing Boundary of GMRL, R-2.
(4) **Geothermal Resource Mining Lease: R-3**

**Issued To:** Barnwell Geothermal Corp.

**Location:** Pohoiki, Puna, Hawaii

**TMK:**
- 1-3-45: 9, 10, 14, 16-18, 21, 22, 25
- 1-3-46: 2-5, 13-25, 29, 30, 33-74, 76, 78, 79, 81, 82, 84
- 1-3-08: 6, 7, 19 (currently noted as TMK 1-3-08: 6, 19, 22-32)
- 1-3-09: 7 (currently noted as 1-3-45: 33-39)
- 1-4-01: Portion of 20 (currently noted as TMK 1-4-90: 1-13, 15 18-27)

**Area:** 769.14 acres

**Land Ownership:** J.T. Trading Co., Ltd. and Auto Imports of Hawaii, Inc.

**Effective Date:** September 1, 1981

**Term:** 10 years primary, 65 years maximum

**General Information:**

- Wells Drilled to Date: Lanipuna No. 1 / **LANIPUNA NO. 1 RE-DRILL**
  Lanipuna No. 6 (DIRECTIONAL)

- Leased Area Zoned: Agriculture

- Mineral Rights: The following parcels, TMK: 1-3-08: 6, 7, 19, have no mineral reservations. All other parcels have mineral rights reserved to State of Hawaii, subject to verification by Division of Land Management.

- See Figure 4
Figure 4. Tax Map Key Showing Boundary of GMRL, R-3.
(5) Geothermal Resource Mining Lease: R-4 (pending)

Issued To: Puna Geothermal Venture (Thermal Power Co., Dillingham, Amfac)

Location: Kapoho, Puna, Hawaii

TMK: 1-4-16: 1-3, 5-11, 13
     1-4-17: 2, 3, 6-12
     1-4-18: 1-5, 7-10, 13
     1-4-19: 1-3, 9
     1-4-20: 7, 8
     1-4-21: 2-4

Area: 279.38 acres

Land Ownership: Various owners who have executed an assignment of their occupier rights to PGV

Effective Date: September 1, 1982 (lease document in preparation)

Term: 10 years primary, 65 years maximum

General Information:

- No exploratory drilling to date
- Leased Area Zoned: Agriculture
- Mineral rights reserved to State of Hawaii, subject to verification by Division of Land Management
- Lease application applies to 279.377 acres out of a total area covering 425.28 acres. The owners of the following parcels declined to enter into leasing agreement:
  TMK: 1-4-16: 3, 4, 7; 1-4-17: 4, 5; 1-4-18: 6, 11;
       1-4-19: 4-8, 11, 12; 1-4-20: 1-5; 1-4-21: 1, 5-7
- See Figure 5
Figure 5. Tax Map Key Showing Boundary of GMRL, R-4.
## DRILLING PERMITS ISSUED BY DLNR

<table>
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<tr>
<th>Well Name</th>
<th>Permit Date</th>
<th>Status</th>
<th>Operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>FNB No. 2</td>
<td>9/26/78</td>
<td>Expired (9/26/79)</td>
<td>Puuwaawaa Steam Co. (partnership between GEDCO and F. Newell Bohnett)</td>
</tr>
<tr>
<td>HGP-A</td>
<td>9/10/79</td>
<td>Completed (in production)</td>
<td>Research Corporation of the University of Hawai'i</td>
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<tr>
<td>Ashida No. 1</td>
<td>1/10/80</td>
<td>Expired (1/10/81)</td>
<td>GEDCO</td>
</tr>
<tr>
<td>(Opihikao No. 1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lanipuna No. 1</td>
<td>1/20/81</td>
<td>Expired (9/20/83)</td>
<td>Barnwell Geothermal Corp.</td>
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<tr>
<td>(Sidetrack)</td>
<td>4/20/82</td>
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<td></td>
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<tr>
<td>Daiichi No. 1</td>
<td>3/2/81</td>
<td>Expired (3/2/82)</td>
<td>GEDCO</td>
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<tr>
<td>Lanipuna No. 6</td>
<td>11/10/83</td>
<td>In progress</td>
<td>Barnwell Geothermal Corp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(expires 11/10/84)</td>
<td></td>
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<tr>
<td>Kapoho State No. 1</td>
<td>3/19/81</td>
<td>Expired (9/14/83)</td>
<td>Puna Geothermal Venture (PGV)</td>
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<tr>
<td>Kapoho State No. 2</td>
<td>1/8/82</td>
<td>Expired (7/7/83)</td>
<td>PGV</td>
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</table>
SPECIAL PERMITS ISSUED BY THE
COUNTY OF HAWAII AND THE STATE LAND USE COMMISSION

Project: Puuwaawaa Steam Co.  Area: 143 acres
Permit No.: SP 79-333  TMK: 7-1-5: 56
(LUC 411)
Effective Date: 6/1/79  Expiration: 7/1/82
Issued To: Geothermal Exploration and Development Co. (GEDCO)

General Information:
- Landowner: Mr. F. Newell Bohnett
- No mineral reservations or mining lease
- Land Use Zoning: Agriculture

Project: HGP-A  Area: 4.1 acres
Permit No.: SP 78-307  TMK: 1-4-01: Portion of 2
(LUC 392) (currently noted as parcel 82)
Effective Date: 2/7/79  Expiration: ongoing
Issued To: Research Corporation of the University of Hawaii

General Information:
- Refer to GRML S-4602

Project: Ashida No. 1  Area: 120 acres
(Ophihikao No. 1)
Permit No.: SP 77-265  TMK: 1-3-01: 24, 25
(LUC 364)
Effective Date: 7/14/77  Expiration: 12/31/87
Issued To: GEDCO

General Information:
- Land Owner: Mr. Harold Ashida and Mr. Vern Yamanaka
- No mineral reservations or mining lease; mineral rights leased to GEDCO.
- Land Use Zoning: Agriculture
- Drilling permit issued for only 49.6 acres (TMK 1-3-01: 24)
Project: Lanipuna (6 wells)  
Area: Portion of 769.14 acres

Permit No.: SP 471  
TMK: 1-3-8: 6, 7, 19  
1-3-9: Portion of 7

Effective Date: 12/16/80  
Expiration: 12/31/87

Issued To: Barnwell Geothermal Corp.

General Information:
- Refer to GRML R-3

Project: Daiichi No. 1  
Area: 180 acres

Permit No.: SP 80-347  
(TMUC 460)

Effective Date: 2/13/81  
Expiration: 12/31/87

Issued To: GEDCO

General Information:
- Landowner: Daiichi Seiko of Hawaii, Inc.
- No mineral reservations or mining lease. Mineral rights leased to GEDCO
- Land Use Zoning: Agriculture
- No exploratory drilling; site only

Project: Kapoho State (2 wells)  
Area: Portion of 815.99 acres

Permit No.: SP 468  
(TMUC 460)

Effective Date: 10/15/80  
Expiration: 10/15/86

Issued To: Thermal Power Co. (PGV)

General Information:
- Refer to GRML R-2
- Testing Program underway

- 1-4-01: 1  
- 1-4-01: 2 (portion)  
- 1-4-01: 3  
- 1-4-01: 19  
- 1-4-01: 58

- 247.00 acres

- 815.80
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<tr>
<th>Well Name</th>
<th>Status</th>
<th>Driller</th>
<th>Depth Drilled (ft.)</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>FNB No. 2</td>
<td>Abandoned (converted to water)</td>
<td>WRII*</td>
<td>6800</td>
<td>No completion (need to report filed. Follow up.)</td>
</tr>
<tr>
<td>HGP-A</td>
<td>Completed (experimental production)</td>
<td>WRII</td>
<td>6450</td>
<td>Well completion report received.</td>
</tr>
<tr>
<td>Ashida No. 1</td>
<td>Suspended</td>
<td>WRII</td>
<td>8000</td>
<td>Partial report filed. 4/14/84</td>
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<td>(Opihikao No. 1)</td>
<td></td>
<td></td>
<td></td>
<td>(No electric log or flow data report.)</td>
</tr>
<tr>
<td>Lanipuna No. 1</td>
<td>Restart/slant drilling 5/10/83</td>
<td>WRII</td>
<td>8000</td>
<td>Completion report (partially filed)</td>
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<tr>
<td></td>
<td>(Initial Shallow)</td>
<td></td>
<td></td>
<td>(Confidential) Log</td>
</tr>
<tr>
<td>Dalichi No. 1</td>
<td>Not drilled</td>
<td>--</td>
<td>7000</td>
<td>Site only (prop.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lanipuna No. 2</td>
<td>Not drilled</td>
<td>WRII</td>
<td>7000</td>
<td>Casing and conc. (prop.) cellar in place.</td>
</tr>
<tr>
<td>Lanipuna No. 3</td>
<td>Not drilled</td>
<td>--</td>
<td>7000</td>
<td>Site only (prop.)</td>
</tr>
<tr>
<td>Lanipuna No. 6</td>
<td>Active</td>
<td>WRII</td>
<td>5000</td>
<td>Drilling began (prop.) Feb. 1984</td>
</tr>
<tr>
<td>Kapoho State No.1</td>
<td>Testing</td>
<td>WRII</td>
<td>7290</td>
<td>Well completion report received.</td>
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<tr>
<td>Kapoho State No.2</td>
<td>Testing</td>
<td>WRII</td>
<td>8005</td>
<td>Well completion report received.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(Not to CHIC w/ DORES)</td>
</tr>
</tbody>
</table>

*Water Resources International
Figure 6. Portion of Puu Anahulu Quadrangle Map Showing Site of Geothermal Well FNB No. 2.
Figure 7. Portion of Pahoa South Quadrangle Map Showing Geothermal Well Sites Located in the Puna District.

-16-
CAMPBELL ESTATE GEOTHERMAL PROJECT (Kahaualea)

Location: Kahaualea, Puna, Hawaii

TMK: 1-1-01: 1
     1-2-08: 1

Area: 25,461.31 acres

Land Ownership: James Campbell Estate

Pending Sublease To: True/Mid-Pacific Geothermal Venture

General Information:

- Geothermal Mining Lease application to include 25,059 acres out of approximately 25,613 acres owned by Campbell Estate.

- Proposed lease area includes both Conservation zoned lands (22,533 acres) and Agriculture zoned lands (2,928 acres).

- Project site bordered on the west and southwest by Volcanoes National Park and on the east by the Puna Forest Reserve.

- Development plans to include access road construction, 5 power plant sites, and up to 35 multiple well drilling sites of approximately 3 to 5 acres each, assuming it is possible to conduct directional drilling of up to 6 wells per site.

- On February 25, 1983, the State Board of Land and Natural Resources granted conditional approval of a Conservation District Use Permit to Campbell Estate. The Board's decision allows Campbell Estate to drill up to 8 exploratory wells within a restricted area of the Conservation district or cease exploration when 4 wells show indication of geothermal resource potential.

- The Board set forth conditional requirements to study air quality, meteorological data and noise monitoring to provide the public with safeguards on geothermal emissions.

- Campbell Estate has not applied to the Board of Land and Natural Resources for a mining lease or drilling permit to date.

- Volcanic eruptions have occurred throughout 1983 to present and lava flows have since covered lands within the approved designated area.

- The Board is scheduled to conduct a supplementary hearing for the limited purpose of obtaining data about the effect of these lava flows on Campbell Estates' exploratory drilling plans.
Figure 8. Location Sketch of Proposed Campbell Estate Geothermal Project (Kahaualea) Showing Some of the 1983 Lava Flows.
GEOTHERMAL ENERGY PRODUCTION (HGP-A)

Project: HGP-A Well head Generator Project

Project Funding: U.S. Department of Energy
State of Hawaii
County of Hawaii
Hawaii Electric Light Co. (HELCO)

Design Consultants: Rogers Engineering Co, Inc. of San Francisco
W.A. Hirai and Associates, Inc. of Hilo

Project Management: Research Corporation of the University of
Hawaii (RCUH) for the HGP-A Development Group

Facility Operation: HELCO personnel to provide daily routine
maintenance and operated remotely from HELCO’s
control room in Hilo.

Power Plant Design:

Generator electrical output of 3 megawatts (3,000 Kilowatts) based on
steamflow rate of 60,000 lb/hr at 160 psig and 350°F. 2.8 megawatts
appropriated for HELCO distribution to approximately 2,500 residents in
the Puna district.

Well head assembly and specific equipment designed for protection or
easy removal to avoid lava flows.

Installation of environmental controls to limit air, water and noise
pollution.

Major Plant Components:

Steam Supply System consisting of wellhead, steam flash cyclone
separator to separate steam and water phases, and additional in-line
separator to remove residual liquids.

Turbine-Generator producing 3.0 megawatts of electricity of which 0.2
megawatts allotted for plant auxiliary equipment.

Hydrogen Sulfide Abatement/caustic soda system for removal of H₂S
and other non-condensable gases that are extracted and burned in an
incineration system.

Condenser where exhausted steam from the turbine is separated into
liquid and non-condensable gases. Part of this condensate is used to
replenish the cooling water lost by evaporation.

Cooling Water System where heat is absorbed through a closed water
system and dissipated into the atmosphere by evaporative cooling. The
process occurs when warm water is sprayed down the cooling tower and
is contacted by cool air flowing through the water.
Silica Settling Pond where excess condensate water is combined with the liquid from the separator and travels to a concrete retention pond where silica is deposited and water is then percolated into the ground.

Production Data:

Production of enough electricity to displace 40,000 barrels of crude oil annually (approximately $1.6 million based on 1980 prices). Electricity sold to HELCO and revenue received to offset operating and maintenance costs.

Monthly operating figures received from RCUH outline amounts of geothermal fluids and electricity produced from HGP-A in addition to the gross revenue and calculations of the waived royalties pursuant to geothermal mining lease No. S-4602.

Summary:

Geothermal energy has demonstrated to be one of the more economical and one of the least polluting of all current fuels used for electrical production. If commercialized it would greatly reduce the millions of dollars spent annually for imported fuel.

Also, lower temperature steam development although not directly valuable for electricity production can be used for direct heat application in agriculture and aquaculture.

Geothermal energy production is a feasible alternative to fossil fuels and nuclear energy to supply HELCO’s projected demand of an additional 25 megawatts by 1988.
GEOTHERMAL POWER PLANT

- STEAM-WATER MIXTURE RISES IN WELL
- SEPARATOR SENDS STEAM TO TURBINE
- STEAM TURNS TURBINE AND TURBINE TURNS GENERATOR
- GENERATOR DEVELOPS ELECTRICITY
- STEAM FROM TURBINE GOES TO CONDENSER
- CONDENSER TURNS STEAM TO WATER
- WATER IS SENT TO THE DRAINAGE POND

MAGMA 1200°C HEAT SOURCE

Figure 9. Geothermal Power Plant Diagram.
### SUMMARY OF MONTHLY HGP-A OPERATING FIGURES

<table>
<thead>
<tr>
<th>Month/Year</th>
<th>Steam (1000 lbs)</th>
<th>Brine (1000 lbs)</th>
<th>Net KWH Generated</th>
<th>Gross Revenue</th>
<th>Royalty</th>
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<td>24,250</td>
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<td>40,920</td>
<td>124,600</td>
<td>$ 498</td>
<td>$ 50</td>
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<td>Aug. 1-31, 1981</td>
<td>39,430</td>
<td>42,780</td>
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<td>Sep. 1-4, 1981</td>
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<td>Dec. 11-31, 1981</td>
<td>25,300</td>
<td>42,850</td>
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<td>37,940</td>
<td>49,990</td>
<td>116,600</td>
<td>466</td>
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<td>34,270</td>
<td>41,930</td>
<td>227,400</td>
<td>910</td>
<td>91</td>
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<td>45,350</td>
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<td>46,738</td>
<td>4,674</td>
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<td>77,717</td>
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<td>49,104</td>
<td>1,788,100</td>
<td>96,504</td>
<td>9,650</td>
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<td>Jun. 1982</td>
<td>37,150</td>
<td>47,520</td>
<td>1,744,000</td>
<td>94,124</td>
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<td>49,104</td>
<td>1,790,000</td>
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<td>1,257,900</td>
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<td>47,520</td>
<td>1,800,000</td>
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<td>49,104</td>
<td>1,840,700</td>
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REFERENCES


